AD-A273 460

USACERL Technical Report FF-93/08
September 1993
VIC-Based Engineer FAM (AMIP)

US Army Corps
of Engineers
Construction Engineering
Research Laboratories

The Analysis of Engineer Activity in the Vector-in-Commander (VIC) Battle Simulation

by
Sara E. Ort
Carol Subick

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The Engineer Model Improvement Program (EMIP) was established in 1988 as a comprehensive effort to ensure that engineers are properly represented in the Army's land combat models. EMIP's focus was to enhance the engineer representation of the Vector-In-Commander (VIC) battle simulation. A new engineer module was designed and developed to replace VIC's original representation of the combat engineer functional area. This report documents and analyzes the new engineer module's output.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1993	Final

4. TITLE AND SUBTITLE
The Analysis of Engineer Activity in the Vector-in-Commander (VIC) Battle Simulation

5. FUNDING NUMBERS
4A162784
AT41
SE-Y21

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Construction Engineering Research Laboratories (USACERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
TR-FF-93/08

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of the Chief of Engineers
ATTN: ATSE-CDC
U.S. Army Engineer School
Fort Belvoir, VA 22060-5516

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
The Engineer Model Improvement Program (EMIP) was established in 1988 as a comprehensive effort to ensure that engineers are properly represented in the Army's land combat models. EMIP's focus was to enhance the engineer representation of the Vector-In-Commander (VIC) battle simulation. A new engineer module was designed and developed to replace VIC's original representation of the combat engineer functional area. This report documents and analyzes the new engineer module's output.

14. SUBJECT TERMS
Engineer Model Improvement Program (EMIP)
Vector-in-Commander battle simulation model
engineer functional area model (EFAM)

15. NUMBER OF PAGES
76

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

FOREWORD

This work was performed for the Office of the Chief of Engineers (OCE) under Project 4A162734AT41, "Military Facilities Engineering Technology"; Work Unit SE-Y21, "VIC-Based Engineer FAM (AMIP)." The technical monitor was MAJ David Davis, U.S. Army Engineer School, ATSE-CDC.

The research was conducted by the Facility Systems Division (FF), of the Infrastructure Laboratory (FL), of the U.S. Army Construction Engineering Research Laboratories (USACERL). Alan Moore is Acting Chief, CECER-FF, and Dr. Michael J. O'Connor is Chief, CECER-FL. The USACERL technical editor was William J. Wolfe, Information Management Office.

LTC David J. Rehbein is Commander of USACERL and Dr. L.R. Shaffer is Director.

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THE ANALYSIS OF ENGINEER ACTIVITY IN THE VECTOR-IN-COMMANDER (VIC) BATTLE SIMULATION

1 INTRODUCTION

Background

The Engineer Model Improvement Program (EMIP) was established in 1988 as a comprehensive effort to ensure that engineers are properly represented in the Army's land combat models. The EMIP plan, published by the Engineer Studies Center in August 1988 (Larry Wright, *The Engineer Model Improvement Program Plan*, USAESC-88-6 [U.S. Army Engineer Studies Center, August 1988]) outlined improvements to the engineer representation in three analytical models. The most important of these was the Vector-in-Commander (VIC) battle simulation, a Corps-level, combined arms combat simulation model. The EMIP plan proposed that the resulting model would be able to serve as the first accredited engineer functional area model (EFAM), and to provide the Army with a much improved analytic tool. The U.S. Army Construction Engineering Research Laboratories (USACERL) was tasked with making improvements to the Engineer Module in VIC. In Fiscal Year 1989 (FY89), USACERL began to implement the new representation of the combat engineer function in VIC. In FY90, as an integral part of the overall improvement in VIC's engineer representation, USACERL developed a standalone engineer postprocessor to analyze engineer activity in VIC to assist analysts in their use of the EFAM. Further analysis was needed to refine the postprocessor and document its use.

Objective

The objective of this work is to analyze the engineer activity produced by a new engineer module, and to further develop and document the use of the VIC postprocessor.

Approach

A VIC simulation was run to determine the data that must be input to the program to yield useful results. The output from VIC provided the data for this analysis. There were several contributors to the analysis: USACERL researchers, engineers at the Engineer School, and maintainers of VIC at Fort Leavenworth, KS. Analysis was done through telephone interviews and personal meetings. It was determined that VIC output should consist of chronological engineer activity and engineer summary data. This solution was chosen for its flexibility, and for the opportunities it provides for later development of other analytical tools.

Mode of Technology Transfer

The computer source code, documentation, and required configuration control reports resulting from USACERL's effort were delivered as part of the Engineer Module to the VIC model proponent, the U.S. Army Training and Doctrine Command (TRADOC) Analysis Command at Fort Leavenworth (TRAC-FLVN) in December 1990.

2 OVERVIEW

VIC's expanded capabilities for representing and monitoring engineer mission performance during the battle simulation generated a need for an automated tool to organize the engineer output into coherent records for analysis. The VIC engineer postprocessor was designed as a separate standalone program to fulfill that function.

VIC's engineer module creates two output files during the simulation of a given scenario: ***ENGR.LIS and ***ENSTP.LIS. The names for the engineer output files conform to the standard VIC filename format ***XXX.LIS, where *** is the prefix chosen for the run and XXX is the particular functional data set contained in the file. Engineer activity is recorded via a chronological sequence of records written to the engineer history file ***ENGR.LIS, and information to establish the appropriate data structures for further analysis is contained in the engineer setup file ***ENSTP.LIS. The engineer output files are used as data for the engineer postprocessor, which generates basic reports and creates files to be used by standard database management software for further analysis.

The engineer output files from VIC, together with the engineer postprocessor, provide three methods for analyzing the engineer activity during a scenario run by: (1) examining the VIC output files directly, (2) studying the standard reports generated by the engineer postprocessor, and (3) using a database management system to query databases formed by importing files of standard comma-delimited records created by the postprocessor.

The engineer history file, containing the chronological output from VIC, allows quick observations of engineer events. Each line in the file begins with a letter that indicates the type of record:

A	Asset record
B	Bridging record
D	Defensive Position record
J	Job record
L	Logistics Deficit record
M	Mission (Unassigned) record
N	Non-Engineer Job record
T	Combat Trail record.

This one-letter code is followed by the side, unique identifiers, and the time of the activity in day/hour/minute format. The remainder of the information is specific to the type of record. Sorting this file using the typical operating system's sort utility provides a chronological record of individual elements according to the categories listed above. This is a very useful technique for anyone creating data that may affect engineers, whether developing new scenarios or when making excursions on an existing one. This technique can also facilitate code enhancement and debugging in areas that affect engineers.

The postprocessor provides an automated procedure for organizing the information from the engineer history file and presenting it in a readable format. It produces both summary and detail reports for jobs and assets as well as detailed reports for unassigned missions, logistic deficits, non-engineer job performance, bridging activity and defensive position activity. These reports will be helpful to anyone interested in examining the engineer activity and results of a VIC run.

There are 27 comma-delimited ASCII files created by the engineer postprocessor. Most commercial relational database management systems, such as INGRES and dBASE, can import these files, which contain all of the information needed to recreate the engineer activity in a particular scenario. In addition, they contain a scenario-identifying prefix that allows comparison of different scenarios.

3 ENGINEER SETUP FILE

The engineer setup file (named ***ENSTP.LIS according to VIC file naming conventions) contains scenario-dependent information that is basic to the simulation. The data items found in this file are:

TIME:	Length of the scenario in Day/Hour/Minute format
MISSION COUNT:	Number of engineer missions
X,Y ORIGIN:	Used if scenario is offset from (0.,0)
X,Y GRID WIDTH:	Width in units, usually kilometers
X,Y NUMBER OF GRIDS:	Total number of X and Y grids
NUMBER OF ASSET PROTOTYPES:	Total number of engineer assets
ASSET PROTOTYPE NAMES:	The FL weapon name for each engineer asset
NUMBER OF BLUE/RED HQ UNITS:	Total blue and red engineer headquarter units
HQ NAMES:	The GG name for each engineer headquarter unit
MAXIMUM BLUE/RED FREE WORK TEAMS:	Total number of blue and red work teams not used in the run.

TIME contains the length of simulated time the scenario actually ran. If the program aborted early, TIME will indicate that. TIME, X,Y ORIGIN, X,Y GRID WIDTH, and X,Y NUMBER OF GRIDS are for information only now, but would be necessary for establishing a playback capability. (This is discussed more fully in Chapter 7, RECOMMENDATIONS, p 51). MISSION COUNT, NUMBER OF ASSET PROTOTYPES, and NUMBER OF BLUE/RED HQ UNITS allow the postprocessor program to create missions, asset prototypes, and headquarter units as permanent entities, all of which allows faster processing. The ASSET PROTOTYPE NAME and HQ NAME are used in printing reports. The number of units created for work teams is an input data item in the global ground (GG) data module. The MAXIMUM BLUE/RED FREE WORK TEAMS indicates the numbers of excess work teams created for each side. With the MAXIMUM BLUE/RED FREE WORK TEAMS known, the appropriate input data item in the GG module can be reduced to save memory and run time on succeeding runs.

4 ENGINEER HISTORY FILE

Introduction

The engineer history file is a chronological listing of engineer activity records. Appendix A includes an example of the unsorted and sorted records from the engineer history file. Since the tracking of engineer effort is the primary focus, the engineer output from VIC centers around engineer jobs. The "J" records track explicit engineer task performance. The "N" records show the non-engineer or implicit jobs. Three terrain features that engineers affect and about which information is recorded also account for record lines in the history file. They are: (1) bridging records (designated by "B"); (2) defensive position records (designated by "D"); and (3) combat trail records (designated by "T"). Engineer assets are tracked by "A" records. An "L" record is written when it is determined that supplies required for the engineer equipment are unavailable. Finally, when a mission fails to be assigned, an "M" record is written. This can happen during the assignment process or when the simulation ends before assigning the mission.

Understanding how the information in these records relates to the other records is important for successfully using this file. All engineer missions created during a run of the simulation will be tracked, either in a job record sequence, a non-engineer task performance record, or an unassigned mission record. The terrain features altered by engineers and recorded in bridging, defensive position, and combat trail output lines will have corresponding job or non-engineer records. Asset records can be cross-checked with engineer job records and with engineer unit records. Logistic records refer to specific ground units and can be cross-checked with explicit engineer or implicit non-engineer job records in the sense that deficiencies are detected within a unit and for a specific task.

Following is a more detailed explanation of the record types in the engineer history file. All times are in the day/hour/minute format.

Job Records

A line is written to the engineer history file for each stage of a job. The sequence of data on the line depends on the job status although all job records begin with the following sequence:

"J":	Jobs and Assigned Missions record type
SIDE:	"1" = Blue "2" = Red
MISSION NUMBER:	The associated mission number for this job
JOB NUMBER:	The entity's memory location. This number and the mission number together form a unique identifier for the job
CURRENT TIME:	Day/Hour/Minute

STATUS OF THE JOB:
" 1" = Create
" 2" = Activate Phase
" 3" = Begin Segment
" 4" = Adjust Segment Duration
" 5" = End Segment
" 6" = Complete Phase
" 7" = Complete Job
" 8" = Complete Mission
" 9" = Preempt Equipment
"10" = Discontinue-Attrition
"11" = Discontinue-Late Finish
"12" = Discontinue-Related Jobs.

As the status of the job changes, different information is included in the job record update. The format of these job records is given according to the status being reported:

1 Create the job:

TASK TYPE:	The type of engineer activity: " 1" = Breach minefield " 2" = Clear minefield " 3" = Breach line obstacle " 4" = Breach obstacle complex " 5" = Improve line breach " 6" = Repair road crater " 7" = Build combat trail " 8" = Emplace minefield " 9" = Emplace line obstacle "10" = Emplace complex obstacle "11" = Prepare bridge for demolition "12" = Prepare position "13" = Crater road "14" = Maintain road.
FEATURE TYPE:	The particular item being worked on
TECHNIQUE:	Method for doing the job
RESPONSIBLE HQ UNIT:	Determined by chain of command
X LOCATION, Y LOCATION:	Job site
SIZE:	Dependent on task
EARLIEST START TIME:	Soonest engineers may begin job
LATEST COMPLETION TIME:	Time job must be completed
REQUESTING UNIT:	"-" if none
ORIGINAL MISSION NUMBER:	May be specified in data
OBSTACLE COMPLEX NUMBER:	0 if not an obstacle complex job
OBSTACLE COMPLEX NAME:	Type of complex

2 Activate this phase:

TECHNIQUE:	Technique actually being used for the job. May have changed since "create" record.
PRIORITY:	Number indicating relative importance of this job as compared with others assigned same HQ.
FIRST SEGMENT NUMBER:	Segment range.
LAST SEGMENT NUMBER	

3 Begin this segment:

SEGMENT NUMBER:	Current segment.
SEGMENT DELAY INDICATOR:	1: Minimum amount of equipment 2: Poor weather 3: Both.
NUMBER OF WORK TEAMS:	In this phase.

4 Adjust this segment duration:

SEGMENT NUMBER:	Current segment.
ADJUSTED TIME:	Adjusted while reconciling asset count.

5 End of this segment:

SEGMENT NUMBER:	Current segment.

6 Complete this phase:

SEGMENT NUMBER:	Current segment.

7 Complete this job:

0	To be used later; skipped in the postprocessor.

8 Complete the mission:

BLANK	No additional information needed.

9 Pre-empt equipment for higher priority job:

SEGMENT NUMBER:	Last segment completed.

10 Discontinue due to attrition of equipment:

SEGMENT NUMBER	Last segment completed
INFORMATION	0: Discontinued while processing job 1: While reconciling asset counts.

11 Discontinue when finish time exceeds completion time:

SEGMENT NUMBER:	Last segment completed.
DISCONTINUE REASON:	0: Not enough time to finish 1: Lack of equipment 2: Delayed by weather 3: Both 1 and 2.

12 Discontinue jobs related to mission jobs already discontinued:

SEGMENT NUMBER:	Last segment completed.
COMPLETED EFFECT:	Effect of engineer effort.

Table 1 shows a selection of job records. The first job is for Mission 1. There is only one job in that mission. The task is 12, indicating that engineers created a defensive position for blue unit 111IN. It was requested (status 1: create job) at the beginning of the simulation during the loading of the data and assigned (status 2: assign job) before the simulation began. The work team began working (status 3: begin segment) at 23 minutes into the simulation. The job was finished (status 8: complete mission) at 00:01:53 (day, hour, minute); the job took 1.5 hours. In the defensive position records, there will be a line showing this position fully completed at 00:01:53 also.

Mission 10 is of task type 7, "build a combat trail." Similar kinds of information are obtained from the job records with a corresponding line appearing in the combat trail records.

The next three jobs are to emplace obstacle complex 15 of type COMPLEX3. A COMPLEX3 has two minefields and one tank ditch, all of which is determined by input data in the MF data module. One mission (13) was created to emplace the two minefields, each being a separate job. The tank ditch is a separate mission (14) because each mission can have only one associated task type. Both missions have the same location, that of the center of the obstacle complex. When the first minefield was completed, the job was completed (status 7: complete job), but the mission was not completed until the second minefield was emplaced (status 8: mission complete).

Another item to note is that the second minefield was started after the first was finished, while the tank ditch was begun independently. This is possible for two reasons. The same equipment can be used for multiple jobs in the same mission, with job performance proceeding sequentially. If the minefield jobs were in separate missions (which can be specified in the input data for the obstacle complex), then two sets of equipment would be sent to the site and the start time of the second job would depend on the availability of equipment. Since different equipment is used to emplace tank ditches, the start time for that job is totally independent of the minefield jobs.

Following the emplace line obstacle job is a bridge demolition job (task type 11). This type of job is created when a request to prepare a bridge for demolition is indicated at the beginning of the simulation in the terrain-barrier (TB) data module or during the simulation as an external event. At the completion

Table 1

Blue Job Records From the Engineer History File

J	B/R	MS	JOB	TIME	ST	TK	FT	TECH	HQ	X	Y	SIZE	ST TIME	END TIME	REQ UNIT	ORG MS	OC	NAME
J	1	1	9261072	0 0 0	1	12	2	24	2	541.100	-21.540	0.	0 0 0	2 0 0	111IN	0	0	
J	1	1	9261072	0 0 0	2			24		70.000	1	1						
J	1	1	9261072	0 0 23	3			1	2	1								
J	1	1	9261072	0 1 53	5			1										
J	1	1	9261072	0 1 53	6			1										
J	1	1	9261072	0 1 53	7					0.								
J	1	1	9261072	0 1 53	8													
J	1	10	9739420	0 0 0	1	7	3	12	1	549.000	-30.100	0.	0 0 0	1 6 0	132AR	1	0	
J	1	10	9739420	0 0 0	2			12		1242.000	1	1						
J	1	10	9739420	0 1 40	3		1	2	1									
J	1	10	9739420	0 3 40	5		1											
J	1	10	9739420	0 3 40	6		1											
J	1	10	9739420	0 3 40	7				0.									
J	1	10	9739420	0 3 40	8													
J	1	13	9740584	0 0 0	1	8	3	13	3	575.500	-10.750	500.000	0 0 0	0 2 0	-	15	15	COMPLEX3
J	1	13	9740584	0 0 0	2			13		1756.583	1	2						
J	1	13	9740584	0 0 49	3		1	0	1									
J	1	13	9740584	0 1 4	3		2	2	1									
J	1	13	9740584	0 1 4	5		1											
J	1	13	9740584	0 1 19	5		2											
J	1	13	9740584	0 1 19	6		2											
J	1	13	9740584	0 1 19	7				0.									
J	1	13	9740816	0 0 0	1	8	3	13	3	575.500	-10.750	500.000	0 0 0	0 2 0	-	15	15	COMPLEX3
J	1	13	9740816	0 1 19	3		1	0	1									
J	1	13	9740816	0 1 34	3		2	2	1									
J	1	13	9740816	0 1 34	5		1											
J	1	13	9740816	0 1 49	5		2											
J	1	13	9740816	0 1 49	6		2											
J	1	13	9740816	0 1 49	7				0.									
J	1	13	9740816	0 1 49	8				0.									
J	1	14	9741608	0 0 0	1	9	3	16	3	575.500	-10.750	0.800	0 0 0	0 2 0	-	15	15	COMPLEX3
J	1	14	9741608	0 1 27	3		1	2	1									
J	1	14	9741608	0 1 51	5		1											
J	1	14	9741608	0 1 51	6		1											
J	1	14	9741608	0 1 51	7				0.									
J	1	14	9741608	0 1 51	8													
J	1	21	9742632	0 0 0	1	11	1	18	3	578.650	-13.400	0.	0 0 0	2 0 0	CORPSFWD	0	0	
J	1	21	9742632	0 0 5	2			18		1762.333	1	1						
J	1	21	9742632	0 0 18	3		1	0	1									
J	1	21	9742632	0 0 33	5		1											
J	1	21	9742632	0 0 33	6		1											
J	1	21	9742632	0 0 33	7				0.									
J	1	21	9742632	0 0 33	8													

Table 1 (Cont'd)

J	B/R	MS	JOB	TIME	ST	TK	FT	TECH	HQ	X	Y	SIZE	ST TIME	END TIME	REQ UNIT	ORG	MS	OC	NAME
J	1	22	9742632	0 0 21	1	3	1	3	3	573.245	-16.074	0.	0 0 21	0 5 57	121IN		0	0	
J	1	22	9742632	0 0 26	2			3		164.733	1	1							
J	1	22	9742632	0 0 33	3		1	2	1										
J	1	22	9742632	0 0 48	5		1												
J	1	22	9742632	0 0 48	6		1												
J	1	22	9742632	0 0 48	7				0.										
J	1	22	9742632	0 0 48	8														
J	1	33	8044188	0 4 0	1	10	2	17	2	545.500	-21.900	0.	0 6 0	2 0 0			16	16	COMPLEX2
J	1	33	8044188	0 6 0	2		17		1738.500	1	1								
J	1	33	8044188	0 6 27	3		1	0	1										
J	1	33	8044188	0 6 57	5		1												
J	1	33	8044188	0 6 57	6		1												
J	1	33	8044188	0 6 57	7				0.										
J	1	33	8044188	0 6 57	8														

of the job, a bridge demolition record will be written. Once a bridge is prepared, there are several ways it can be demolished. This will be discussed in the section on Bridge Demolition Records.

Mission 22 is a task of type 3, line obstacle breach. It was created after the simulation began, when unit 121IN realized it would encounter a river without a bridge. The latest completion time was calculated to be 00:05:57, which is the time that the unit would have arrived and been able to cross the river without engineer help. The job finished at 00:00:48, allowing the unit to cross using the river's breached delay time upon arriving at the encounter point.

The last blue engineer job is to emplace obstacle complex 16 of type COMPLEX2 as a whole. This is in contrast to complex 15. When specified in the data, engineers can emplace whole obstacle complexes regardless of the individual components. To do this, engineer input data must specify a technique for emplacing an obstacle complex of type COMPLEX2. The obstacle plan for this scenario did not call for engineers to begin construction of this complex until 00:06:00, as shown by the earliest start time.

During the course of the simulation, the red engineers have engineer jobs similar to the blue side. Table 2 shows red engineer jobs created as a result of activity by the blue engineers. Missions 44 and 45 are to breach the two minefields and the tank ditch in obstacle complex 15, emplaced by blue engineers and reported in Table 1. Red unit 11MR encountered the complex at 00:23:00 and needed engineers to breach it before 1:06:00. The minefields were breached by 00:23:49 and the tank ditch by 00:23:43.

The last two red jobs shown involve the same breach. The first is a task of type 3, breach line obstacle; the second is a task of type 5, improving a line breach. If a river is bridged by equipment that is left at the site and retrieved later, a request is made for improvement of this breach site so that the equipment can be retrieved by the unit that owns it. However, there will be only one bridging record for creating this bridge.

Though the records of the engineer history file are formatted to allow a simple alphanumeric sort to organize them into a usable format, simultaneous events may be placed in the sequence in an order that is not logically consistent with their actual occurrence. For example, in the two emplace minefield jobs in Table 1, the technique used to emplace a minefield in a blue COMPLEX3 specified that the job be accomplished in two segments. In the first emplace minefield job, segment 2 began at the same time as segment 1 ended. Logically, the end of segment 1 should precede the beginning of segment 2. However, Table 1 lists the beginning of segment 2 before the end of segment 1 because of the alphanumeric structure of the two records.

The job creation records appear in the engineer history file in the same order in which the jobs were created. For those created during the initialization process of the simulation, the order is due to the manner in which the input data is processed. Unit path data is processed before terrain and minefield data. Thus, defensive position jobs requested in the unit path data are created before obstacle emplacement jobs. In addition, engineer obstacle emplacements are controlled by the early start times specified in the minefield and terrain-barrier data modules, and are created only when the early start time is within the current engineer cycle. External events can cause bridge preparation jobs to be created at any time during a run. Mobility tasks, such as breaching minefields and bridging rivers, are created when ground units encounter the unbreached obstacles.

Table 2

Red Job Records From the Engineer History File

J	B/R	MS	JOB	TIME	ST	TK	FT	TECH	HQ	X	Y	SIZE	ST TIME	END TIME	REQ UNIT	ORG MS	OC	OC NAME
J	2	44	9261072	0 23 0	1	1	3	27	4	575.500	-10.750	0.250	0 23 0	1 6 0	11MR	0	15	COMPLEX3
J	2	44	9261072	0 23 5	2			27		2263.292	1	1						
J	2	44	9261072	0 23 28	3		1	2	1									
J	2	44	9261072	0 23 35	5		1											
J	2	44	9261072	0 23 35	6		1											
J	2	44	9261072	0 23 35	7				0.									
J	2	44	9261352	0 23 0	1	1	3	27	4	575.500	-10.750	0.250	0 23 0	1 6 0	11MR	0	15	COMPLEX3
J	2	44	9261352	0 23 35	3		1	2	1									
J	2	44	9261352	0 23 43	5		1											
J	2	44	9261352	0 23 43	6		1											
J	2	44	9261352	0 23 43	7				0.									
J	2	44	9261352	0 23 43	8				0.									
J	2	45	9813008	0 23 0	1	3	3	35	4	575.500	-10.750	0.	0 23 0	1 6 0	11MR	0	15	COMPLEX3
J	2	45	9813008	0 23 5	2		35			2256.790	1	1						
J	2	45	9813008	0 23 28	3		1	0	1									
J	2	45	9813008	0 23 43	5		1											
J	2	45	9813008	0 23 43	6		1											
J	2	45	9813008	0 23 43	7				0.									
J	2	45	9813008	0 23 43	8													
J	2	46	9261352	1 0 16	1	3	1	31	5	578.576	-13.400	0.	0 3 38	2 0 0	RENG1	0	0	
J	2	46	9261352	1 0 17	2		31			166.273	1	1						
J	2	46	9261352	1 0 22	3		1	2	1									
J	2	46	9261352	1 0 37	5		1											
J	2	46	9261352	1 0 37	6		1											
J	2	46	9261352	1 0 37	7				0.									
J	2	46	9261352	1 0 37	8													
J	2	47	9743376	1 0 37	1	5	4	39	5	578.576	-13.400	0.	0 3 38	2 0 0	RENG1	0	0	
J	2	47	9743376	1 0 42	2		39			1261.224	1	1						
J	2	47	9743376	1 2 22	3		1	0	1									
J	2	47	9743376	1 8 52	5		1											
J	2	47	9743376	1 8 52	6		1											
J	2	47	9743376	1 8 52	7				0.									
J	2	47	9743376	1 8 52	8													

Non-Engineer Job Records

Maneuver units can perform engineer tasks implicitly using organic equipment. An output record indexed by the letter "N" is written to the engineer history file whenever such a job is accomplished by non-engineer units. The format for the non-engineer (implicit) task performance record is:

"N":	Non-Engineer Jobs record type
SIDE:	"1" = Blue "2" = Red
UNIT:	Unit doing the implicit job
TIME:	Completion time; Day, Hour, Minute
TASK TYPE:	Type of job
FEATURE TYPE:	Item working on
TECHNIQUE:	Method for work
X,Y LOCATION:	Job site
DURATION:	Length of effort on job; delay to unit
EFFECT:	Indicates amount of the job completed; "1.0" = 100%, "0.0" = 0%.

Table 3 shows records of implicit engineer work. In the first record, the unit 113AR prepared its own defensive position. Several defensive position records will be created for this position as its level of completion increases, but only one non-engineer task performance record is created. That one record marks the completion of the non-engineer effort, which may coincide with the completion of the defensive position, or which may coincide with the unit's leaving the position or being interrupted by enemy fire.

The next set of jobs is at the same location. This is the location of the obstacle complex 15 that has been discussed in the explicit engineer job examples. Unit 12MR encountered this complex after unit 11MR, which requested engineer assistance. Unit 12MR had the appropriate engineer capability to breach the complex itself. After engineers completed the job for 11MR, the strengths of the individual elements in the complex are reduced according to the size of the unit and the percentage of the obstacle complex encountered. After the complex is encountered, it is possible to have enough of the complex remaining

Table 3

Non-Engineer Job Records

N	B/R	UNIT	TIME	TASK	FEAT	TECH	X	Y	DURATION	EFFECT
N	1	113AR	0 2 42	12	1	23	539.000	-12.000	0.510	1.000
N	2	12MR	0 13 58	1	1	27	575.500	-10.750	0.100	1.000
N	2	12MR	0 13 59	1	1	27	575.500	-10.750	0.125	1.000
N	2	12MR	0 14 2	3	5	35	575.500	-10.750	0.250	1.000
N	2	12MR	1 13 23	1	1	27	574.575	-24.000	0.100	1.000
N	2	12MR	1 13 26	1	1	27	574.575	-24.000	0.150	1.000
N	2	12MR	1 13 27	3	1	37	570.325	-22.000	0.500	1.000
N	2	12MR	1 13 27	3	5	35	574.575	-24.000	0.350	1.000
N	2	RENG2	1 8 0	12	1	50	544.000	-33.000	4.000	1.000

to impair another unit. This is why unit 12MR is still needed to breach the complex. Notice that the time it took for unit 12MR to breach the two minefields and the tank ditch is very short. This is probably due to a small portion of the complex remaining or a small portion of the unit encountering the complex.

The third group of records show again how the sorting can be confusing. The first, second, and fourth records in that group are at the same location. The fourth record is another complex at that location, a tank ditch. However, the third record is a river breaching. It was placed in this position because the time and task are the same as the tank ditch, but the feature is different.

While all engineer tasks can be completed implicitly, mobility tasks are done by non-engineers more often than other tasks. This small data set is consistent with that. Task 1 is breaching minefields and Task 3 is breaching line obstacles. Minefields, line obstacles, and complexes are often unknown and bridges can be blown. So the maneuver unit cannot always plan obstacles. The first and last jobs are not mobility tasks, but they do coincide with mobility. They are task 12: preparing a defensive position. When a unit arrives at a location where it intends to pause, it will begin to provide cover for itself if capable. This can be anticipated and engineer help requested, but availability of resources often makes it impossible to accomplish by engineers.

Bridging Records

A line is written to the engineer history file when a bridge is created, prepared for demolition or demolished, whether the activity is accomplished explicitly or implicitly, or independent of engineers. Bridge completion, engineer preparation for demolition, and bridge demolition can be specified at the start of the simulation in the Terrain Barrier input data. Bridge completion may occur during the course of the simulation when engineers complete a bridging task. Preparation for demolition and actual demolition can be ordered by the external event file. The following information is written for all bridging records:

"B":	Bridging and Bridge Demolition record type
SIDE:	"0" = Neutral
	"1" = Blue
	"2" = Red
BRIDGE NUMBER:	The entity's memory location, a unique identifier
CURRENT TIME:	Day, Hour, Minute
BLUE DEMO FLAG:	"0" = unprepared
	"1" = prepare by engineers
	"2" = blow when prepared
RED DEMOLITION FLAG:	Same as for blue flag
X,Y LOCATION:	Job location
COMPLETION FACTOR:	Value between 0.0 and 1.0
UNIT NAME:	Unit responsible for demolition.

Table 4 shows a sample of bridging records. The neutral bridges existed at the beginning of the simulation as part of the theater infrastructure. Any bridge that is not neutral has been subject to some kind of engineer activity, and data fields may have changed from the original creation record. The key

Table 4

Blue and Red Bridging Records

B	B/R	BRIDGE	TIME	B FLAG	R FLAG	X	Y	COMP	UNIT
B	0	9245456	0 0 0	0	0	569.000	-18.900	1.000	-
B	0	9245520	0 0 0	0	0	578.650	-13.400	1.000	-
B	0	9249488	0 0 0	0	0	569.050	-3.850	1.000	-
B	0	9249552	0 0 0	0	0	548.700	16.700	1.000	-
B	1	9245456	0 0 0	0	0	569.000	-18.900	1.000	-
B	1	9245456	0 0 0	0	0	569.000	-18.900	1.000	122AR
B	1	9245456	0 0 36	1	0	569.000	-18.900	1.000	122AR
B	1	9245456	0 3 10	1	0	569.000	-18.900	0.	122AR
B	1	9245520	0 0 0	0	0	578.650	-13.400	1.000	-
B	1	9245520	0 0 33	1	0	578.650	-13.400	1.000	-
B	1	9245520	0 4 0	0	0	578.650	-13.400	0.	CORPSFWD
B	1	9249552	0 1 0	0	0	548.700	16.700	0.	CORPSFWD
B	2	9194128	0 3 38	0	0	550.736	15.461	1.000	-
B	2	9194064	1 0 37	0	0	578.576	-13.400	1.000	-

to interpreting the bridging records is to notice the changes between records for a particular bridge, which fields have changed, and in what order the changes occurred.

The first bridge, numbered 9245456, is listed as neutral. Further in the table, four records identify this same bridge as a blue bridge. The neutral record is for its creation in the terrain data. The other four occurrences mean that the blue side is interested in that bridge. The first blue record for this bridge is changed only in the side field. This means that the bridge is to be prepared for demolition by engineers. If it is to be destroyed as soon as preparations are complete, a "2" would appear in the blue flag column. The second line is changed by including unit 122AR. This indicates that the bridge is to be destroyed after unit 122AR crosses it. Orders for preparation and for demolition of a bridge could have been specified in the terrain data or in the external event file, but only the external event file can specify demolition after a ground unit passes the bridge. The third blue record has a time of 00:00:36, and the blue flag is changed to "1", indicating that at 00:00:36 the bridge was prepared for demolition. A corresponding record would appear in the Job or Non-Engineer Job Records, though this is not shown in the small data set included in Tables 1 and 2 in this example. The last record for this bridge was written when the bridge was destroyed. The completed effect for the bridge was set to zero.

The next group of blue bridge records is similar except there was no separate order to destroy the bridge. It was destroyed at 00:04:00 by CORPSFWD. This indicates an external event was scheduled for 00:04:00 to destroy the bridge. The single blue bridge record following this one shows bridge 9249552 as destroyed at 00:01:00 with no previous orders for preparation or demolition. This was an external event to simply destroy the bridge at that time regardless of its condition and independent of engineers.

The two red bridge records refer to two bridges that were created when maneuver units needed them. Normally, there would be corresponding Job records, implicit or explicit. The second red bridge is at the same location as one of the blue bridges that was destroyed. The Job record would indicate how long the red unit was delayed by this destroyed bridge. These Job records are not included in the sample data set.

Defensive Position Records

All defensive positions are created at the beginning of the simulation by a request in the unit movement data, and a line is written to the engineer history file. Whenever there is activity at that position, another line is written. The position can be created as fully completed, partially completed, or not yet started. Any position not fully completed generates an engineer request for completion. The position is associated with the unit that requested it and its position prototype is based on the size and type of that unit. The position can be used by other units requiring the same position prototype, but only after the unit requesting the position has used it and left. Defensive position jobs can be explicit or implicit. If a unit is capable of preparing its own position as specified in input data, it will do so. If not, engineers will be assigned to the task. Regardless, the following information is recorded:

"D":	Defensive Position record type
SIDE:	"1" = Blue
	"2" = Red
DEF POSITION ID:	Position identifier
CURRENT TIME:	Day, Hour, Minute
STATUS:	"1" = Create
	"2" = Update
	"3" = Occupy
	"4" = Destroy
	"5" = Saved by
PROTOTYPE:	Type of position
X,Y LOCATION:	Location of position
COMPLETION FACTOR:	Percent completed
EXPOSURE:	Percent of unit exposed when in position
	This attribute is not connected properly
	in VIC engineer module
UNIT:	Unit depending on status.

Table 5 shows a sample of defensive position records. The first set of records shows a position that was fully prepared at the beginning of the simulation. Unit 111IN moved into that position on the second day and did not leave before the end of the simulation.

The next set of four records is for another position for unit 111IN. This one was 50 percent complete when the scenario began, and was completed before the unit arrived. A corresponding record can be found in Table 1, the blue explicit job records. The unit stayed until 00:18:00. Many times the units travel in a coordinated move. A unit will be told to proceed to a certain location, dig in until a specified time, and when other units arrive or a particular job is complete, continue to the next location.

The next two positions are for unit 113AR. The first one was fully prepared and the unit never arrived. The records for the second position show that the unit never left this position, which is why it did not arrive at the first position listed. Also, the position was prepared after unit 113AR arrived. The non-engineer job records show that this position was prepared by the unit itself. The work on the position is updated whenever ground unit positions are updated, in this scenario, every 15 minutes. The last position was prepared implicitly by a red unit.

Combat Trail Records

Combat trails are needed when the trafficability of a grid cell is poor. They are specifically requested in the Terrain Barrier data for a particular side and are treated as features contained in grid cells.

Table 5

Blue and Red Defensive Position Records

D	B/R	DP ID	TIME	STATUS	PROTO	X	Y	COMP	EXPOS	UNIT
D	1	8043232	0 0 0	1	2	548.000	-28.000	1.000	1.000	111IN
D	1	8043232	1 2 45	3	2	548.000	-28.000	1.000	1.000	111IN
D	1	8043336	0 0 0	1	2	541.100	-21.540	0.500	1.000	111IN
D	1	8043336	0 1 53	2	2	541.100	-21.540	1.000	1.000	111IN
D	1	8043336	0 12 58	3	2	541.100	-21.540	1.000	1.000	111IN
D	1	8043336	0 18 0	4	2	541.100	-21.540	1.000	1.000	111IN
D	1	8045228	0 0 0	1	3	536.580	-27.910	0.	1.000	113AR
D	1	8045228	0 3 22	2	3	536.580	-27.910	1.000	1.000	113AR
D	1	8045332	0 0 0	1	3	539.000	-12.000	0.	1.000	113AR
D	1	8045332	0 1 47	3	3	539.000	-12.000	0.	1.000	113AR
D	1	8045332	0 2 0	2	3	539.000	-12.000	0.647	1.000	113AR
D	1	8045332	0 2 15	2	3	539.000	-12.000	0.772	1.000	113AR
D	1	8045332	0 2 30	2	3	539.000	-12.000	0.897	1.000	113AR
D	1	8045332	0 2 42	2	3	539.000	-12.000	1.000	1.000	113AR
D	2	8074160	0 0 0	1	1	544.000	-33.000	0.	1.000	RENG2
D	2	8074160	1 2 5	3	1	544.000	-33.000	0.	1.000	RENG2
D	2	8074160	1 8 0	2	1	544.000	-33.000	1.000	1.000	RENG2

When the combat trail record is created, information is given indicating whether the trail already exists or must be built. Unlike bridges, a unit is unable to determine the need for a combat trail when crossing into a grid. Missions to build combat trails are generated only in input data.

"T"	Combat Trail record type
SIDE:	"1" = Blue
	"2" = Red
FEATURE:	Identifier for the trail
TIME:	Day, Hour, Minute
STATUS:	"1" = Create the trail feature
	"2" = Build the trail
	"3" = Enter the trail
	"4" = Exit the trail.

Depending on the status, the succeeding fields in a combat trail record contain different information:

INFORMATION:	Create: trafficability of grid
	Build: number of levels trafficability can increase
	Enter: terrain traf. level of grid with trail
	Exit: terrain traf. level of next grid
X,Y LOCATION:	Create: Data location for trail
	Build: job location
	Enter: where unit entered grid
	Exit: where unit exited grid
NAME:	Create: trail type
	Build: work team name
	Enter: unit name
	Exit: unit name.

Table 6 contains records for one combat trail needed by the blue side. The vegetation symbol for the grid is "*", which corresponds to poor trafficability in the terrain relief map. The actual grid cell affected by the combat trail is determined from the location given in the input data. At 00:03:40 the trail was completed under the command of the blue engineer headquarters. There should be a related engineer job record printed. The location specifies the edge of the grid closest to the engineer headquarters responsible for the work. The trail is expected to raise the trafficability of the grid by two levels. At 01:02:21, unit 111IN entered the grid, the trafficability of which is now level 2, and never left. Unit 132AR entered at 01:06:20 and took 25 minutes to traverse the grid. When the unit leaves this grid, it enters one with a much better trafficability (4).

Table 6

Combat Trail Records

T	B/R	TRAIL FEATURE	TIME	STATUS	INFO	X	Y	UNIT
T	1	9119708	0 0 0	1	0	549.000	-28.000	*
T	1	9119708	0 3 40	2	2	549.000	-30.100	BENGHQ
T	1	9119708	1 2 21	3	2	547.000	-27.209	111IN
T	1	9119708	1 6 0	3	2	549.485	-26.001	132AR
T	1	9119708	1 6 25	4	4	550.475	-30.003	132AR

Assets Records

A line is written to the engineer history file when the status of an engineer asset changes. The sequence of data included on this type of line is:

"A":	Asset record type
SIDE:	"1" = Blue
	"2" = Red
ASSET ID:	The entity's memory location, a unique identifier
CURRENT TIME:	Day, Hour, Minute
ASSET STATUS:	"1" = Available
	"2" = In Pretask
	"3" = In Transit
	"4" = Waiting
	"5" = Working
	"6" = Resting
	"7" = Damaged
	"8" = Left at site.
TYPE OF ASSET:	Integer determined by order of the engineer assets listed in the engineer input file
X,Y LOCATION:	The current location
UNDAMAGED PORTION:	The current FL.WG.STRENGTH
MISSION NUMBER:	The mission on which this asset is currently working
JOB NUMBER:	The job identifier for the job on which this asset is currently working
UNIT NAME:	Name of GG.UNIT presently using this asset.

Engineer assets are weapon groups created at the beginning of the simulation in the front line attrition module. Some assets are kept busy continuously and others are never used. This can give valuable information about the scenario developed for the engineers as well as the Table of Organization and Equipment (TOE) for engineer equipment. The command structure has a major effect on how assets are used. Also having an effect are: what units own the assets within a command chain; whether the unit is an engineer unit or a maneuver unit; and what quantity of assets is given to the various units. Jobs may

or may not be completed due to these decisions. If the necessary assets are not owned by the command chain responsible for the area of the job site, the job will not be assigned. If the equipment is too far away from the job site, the job may not be finished in time.

These problems and others can be detected using the engineer history file. It is easy to see the degree to which the assets are used. The first asset in Table 7 has not been used since no other records occur after the one for its creation at the beginning of the simulation. The second asset was used in two jobs. By cross-checking the mission and job numbers of the asset record with the job records, it is known that the first job this asset was used in, was to build a combat trail. It began working at 00:01:40, finished at 00:03:40, and travelled to the next job to prepare a defensive position, beginning at 00:06:33. The same type of equipment, type 6, can be used to create a combat trail, as to create a defensive position. This is controlled by the engineer technique data. The assets always return to their owners, and the owners record their whereabouts. The third asset was used to emplace an obstacle complex. The location and timing should agree with the appropriate job records.

The fourth and fifth assets were used on the same job, in preparing a defensive position. Notice that, since two pieces of equipment worked simultaneously on this job, the work required half the time required for a similar job in which one asset worked alone. The engineer technique data specifies both a minimum number and a preferred number of assets. If less than the preferred number of assets is available, the job duration time is lengthened proportionally.

The sixth asset, type 2, was used to breach a river and was left at the site. At the completion of a bridging job using a retrievable asset, a new mission is automatically generated to improve the line breach and retrieve the asset. The asset becomes available for other missions only after it is retrieved. Since this asset does not become available again, the mission to improve breach and retrieve the asset was not completed. Look for a discontinued job or an unassigned mission.

The type of asset that is used to emplace an obstacle complex is also used to emplace minefields: type 4. The seventh asset was used to emplace the two minefields that make up obstacle complex 15. The next asset, type 5, was used to emplace the tank ditch, also a part of that obstacle complex. Since the two minefields are in the same mission, the same asset will be used. Because they are separate missions as well as different types of assets, the tank ditch job can begin before the minefields are finished, depending on the availability of the asset.

The last asset is a Red Engineer asset. It is a retrievable bridging asset and has been left at the site. However, the records show that this asset has become available, meaning that the improve and retrieve mission was completed. This can also be seen in the engineer job records.

Supply Deficit Records

A logistics line is written to the engineer history file under two conditions. In trying to begin work on a job, the responsible engineer HQ unit checks the availability of supplies for the required engineer assets. This is after it is known that the engineer HQ unit actually has that type of supply in its inventory and is eligible for resupply when the reorder threshold is reached. If the level of supplies on hand is inadequate, a supply deficit record is written to the engineer history file and the job is not started. The

Table 7

Blue and Red Engineer Assets

A	B/R	ASSET ID	TIME	STATUS	TYPE	X	Y	UNDAM	MS	JOB	UNIT
A	1	9511016	0 0 0	1	4	543.000	-44.000	1.000	0	0	BENGHQ
A	1	9511236	0 0 0	1	6	543.000	-44.000	1.000	0	0	BENGHQ
A	1	9511236	0 0 0	2	6	543.000	-44.000	1.000	10	9739420	ENGR_WT175
A	1	9511236	0 0 0	3	6	543.000	-44.000	1.000	10	9739420	ENGR_WT175
A	1	9511236	0 1 40	5	6	549.000	-30.100	1.000	10	9739420	ENGR_WT175
A	1	9511236	0 3 40	3	6	549.000	-30.100	1.000	0	0	ENGR_WT175
A	1	9511236	0 4 0	3	6	547.529	-33.507	1.000	8	8044328	ENGR_WT188
A	1	9511236	0 5 20	3	6	543.000	-44.000	1.000	8	8044328	ENGR_WT188
A	1	9511236	0 6 33	5	6	555.000	-40.000	1.000	8	8044328	ENGR_WT188
A	1	9511236	0 9 33	3	6	555.000	-40.000	1.000	0	0	ENGR_WT188
A	1	9511236	0 9 46	1	6	543.000	-44.000	1.000	0	0	BENGHQ
A	1	9659160	0 0 0	1	4	540.490	-16.870	1.000	0	0	BENG1
A	1	9659160	0 6 0	2	4	540.490	-16.870	1.000	33	8044188	ENGR_WT196
A	1	9659160	0 6 0	3	4	540.490	-16.870	1.000	33	8044188	ENGR_WT196
A	1	9659160	0 6 27	5	4	545.500	-21.900	1.000	33	8044188	ENGR_WT196
A	1	9659160	0 6 57	3	4	545.500	-21.900	1.000	0	0	ENGR_WT196
A	1	9659160	0 7 25	1	4	540.490	-16.870	1.000	0	0	BENG1
A	1	9659584	0 0 0	1	6	540.490	-16.870	1.000	0	0	BENG1
A	1	9659584	0 0 0	2	6	540.490	-16.870	1.000	1	9261072	ENGR_WT170
A	1	9659584	0 0 0	3	6	540.490	-16.870	1.000	1	9261072	ENGR_WT170
A	1	9659584	0 0 23	5	6	541.100	-21.540	1.000	1	9261072	ENGR_WT170
A	1	9659584	0 1 53	3	6	541.100	-21.540	1.000	0	0	ENGR_WT170
A	1	9659584	0 2 17	1	6	540.490	-16.870	1.000	0	0	BENG1
A	1	9659628	0 0 0	1	6	540.490	-16.870	1.000	0	0	BENG1
A	1	9659628	0 0 0	2	6	540.490	-16.870	1.000	1	9261072	ENGR_WT170
A	1	9659628	0 0 0	3	6	540.490	-16.870	1.000	1	9261072	ENGR_WT170
A	1	9659628	0 0 23	5	6	541.100	-21.540	1.000	1	9261072	ENGR_WT170
A	1	9659628	0 1 53	3	6	541.100	-21.540	1.000	0	0	ENGR_WT170
A	1	9659628	0 2 17	1	6	540.490	-16.870	1.000	0	0	BENG1
A	1	9660272	0 0 0	1	2	574.600	-15.910	1.000	0	0	BENG2
A	1	9660272	0 0 26	2	2	573.066	-18.513	1.000	22	9742632	ENGR_WT186
A	1	9660272	0 0 26	3	2	573.066	-18.513	1.000	22	9742632	ENGR_WT186
A	1	9660272	0 0 33	5	2	573.245	-16.074	1.000	22	9742632	ENGR_WT186
A	1	9660272	0 0 48	8	2	573.245	-16.074	1.000	0	0	ENGR_WT186
A	1	9661252	0 0 0	1	4	574.600	-15.910	1.000	0	0	BENG2
A	1	9661252	0 0 0	2	4	574.600	-15.910	1.000	13	9740584	ENGR_WT179
A	1	9661252	0 0 0	3	4	574.600	-15.910	1.000	13	9740584	ENGR_WT179
A	1	9661252	0 0 5	3	4	574.600	-15.910	1.000	13	9740584	ENGR_WT179
A	1	9661252	0 0 49	5	4	575.500	-10.750	1.000	13	9740584	ENGR_WT179
A	1	9661252	0 1 1	5	4	575.500	-10.750	1.000	13	9740584	ENGR_WT179
A	1	9661252	0 1 19	3	4	575.500	-10.750	1.000	13	9740816	ENGR_WT179
A	1	9661252	0 1 19	5	4	575.500	-10.750	1.000	13	9740816	ENGR_WT179
A	1	9661252	0 1 34	5	4	575.500	-10.750	1.000	13	9740816	ENGR_WT179
A	1	9661252	0 1 49	3	4	567.769	-31.257	1.000	0	0	ENGR_WT179
A	1	9661252	0 1 59	1	4	565.890	-45.670	1.000	0	0	BENG2
A	1	9661632	0 0 0	1	5	574.600	-15.910	1.000	0	0	BENG2
A	1	9661632	0 0 0	2	5	574.600	-15.910	1.000	14	9741608	ENGR_WT180
A	1	9661632	0 0 0	3	5	575.500	-10.750	1.000	14	9741608	ENGR_WT180
A	1	9661632	0 1 27	5	5	575.500	-10.750	1.000	14	9741608	ENGR_WT180
A	1	9661632	0 1 51	3	5	575.500	-10.750	1.000	0	0	ENGR_WT180
A	1	9661632	0 3 54	3	5	569.580	-24.686	1.000	0	0	ENGR_WT180
A	1	9661632	0 5 22	3	5	567.384	-34.214	1.000	0	0	ENGR_WT180
A	1	9661632	0 6 34	1	5	565.890	-45.670	1.000	0	0	BENG2
A	2	9665948	0 0 0	1	10	582.180	6.660	1.000	0	0	RENG1
A	2	9665948	1 0 16	2	10	579.670	-12.590	1.000	46	9261352	ENGR_WT195
A	2	9665948	1 0 17	3	10	579.670	-12.590	1.000	46	9261352	ENGR_WT195
A	2	9665948	1 0 22	5	10	578.576	-13.400	1.000	46	9261352	ENGR_WT195
A	2	9665948	1 0 37	8	10	578.576	-13.400	1.000	0	0	RENG1
A	2	9665948	1 8 52	3	10	579.670	-12.590	1.000	47	9743376	ENGR_WT177
A	2	9665948	1 9 15	1	10	582.180	6.660	1.000	0	0	RENG1

second instance occurs when supplies are transferred with assets from headquarters to the work team or from one work team to another. The following fields are found:

"L":	Logistics record type
SIDE:	"1" = Blue
	"2" = Red
UNIT:	Unit needing supplies
CURRENT TIME:	Day, Hour, Minute
SUPPLY TYPE:	Fuel type, ammo type, or job supply type
AMOUNT REQUESTED:	Amount needed
AMOUNT ON HAND:	Amount available.

Table 8 contains examples of the two types of engineer logistics records. The first two records were written when availability of engineer supplies was checked. BATM1 is a mine and is needed when emplacing a minefield with that type of mine. Wire is used as a line obstacle. Since these records do not appear again, either the supplies became available and the jobs were completed, or the jobs were canceled. The third record was a request for fuel, associating the record with a supply transfer. If the job was discontinued, a related record will be found with the job records. If the mission remained unassigned, a record will appear with the unassigned mission records.

Table 8

Engineer Logistics Records

L	B/R	UNIT	TIME	TYPE	REQUESTED	ON HAND
L	1	BENG2	0 0 30	BATM1	10.0	9.5
L	1	BENG2	0 0 57	WIRE	50.0	25.0
L	1	ENGR_WT170	0 16 7	FUEL	100.0	30.0

Unassigned Mission Records

The mission assignment process is not always successful. This may result from a number of different situations: (1) input data may not have a technique for the mission type; (2) it may not be possible to complete the job within the required time; (3) the scenario may have placed no unit with the right equipment in a position to do the work; or, (4) the mission may have been assigned and then unassigned because of changing conditions with the original engineer unit assigned to the task. An unassigned mission record is written to the engineer history file for each such mission. Missions may be canceled during the simulation because of the first two reasons above. Their unassigned mission records appear in the appropriate chronological sequence with the other engineer output records. The missions that remain unassigned at the end of the simulation are all reported as unassigned missions at the end of the engineer history file.

Two or more records can be written for each mission. The first record has the same format for all of the mission task types and contains basic information. The format is:

"M":	Unassigned Mission record type
SIDE:	"1" = Blue
	"2" = Red

MISSION NUMBER:	Mission identifier, storage position
CURRENT TIME:	Creation time
TASK TYPE:	The type of engineer activity " 1" = Breach minefield " 2" = Clear minefield " 3" = Breach line obstacle " 4" = Breach obstacle complex " 5" = Improve line breach " 6" = Repair road crater " 7" = Build combat trail " 8" = Emplace minefield " 9" = Emplace line obstacle "10" = Emplace complex obstacle "11" = Prepare bridge for demolition "12" = Prepare position "13" = Crater road "14" = Maintain road.
ORIGINAL MS NUMBER:	Identifier given in data. Not unique
X,Y LOCATION:	Mission location
START TIME:	Earliest time to start mission
COMPLETION TIME:	Latest time to complete mission
NUMBER OF FEATURES:	Number of jobs within mission
REQUESTING UNIT:	"-" = None
OBSTACLE COMPLEX:	Obstacle complex number; 0 = Not an obstacle complex.
OBSTACLE NAME:	Type of obstacle complex.

The standard unassigned mission record is followed by a line for each feature involved with the mission. For example, a minefield emplacement mission may include several minefields, with the intention of having a single engineer work team emplace the minefields sequentially. The information for the mission features varies depending upon the mission task type. The following list contains the information for each task type. Each line contains a repeat of the record type, side, and mission number so that the sorting of the file will sequence the mission records appropriately. That is, repeating the mission information keeps the records together in proper order when the original file is sorted. Obstacle complex records are found at the end of this list:

1 MINEFIELD BREACH:
"M"
SIDE:
MISSION NUMBER:

MINE TYPE:	Minefield type from the MF data
FRONTAGE:	Length of front
DEPTH:	Used with frontage to determine size
NUMBER OF MINES:	Total in minefield
ORIENTATION:	About the X,Y axis
X,Y LOCATION:	Center of minefield

2 MINEFIELD CLEAR:
"M"
SIDE:
MISSION NUMBER:
MINE TYPE: Type of minefield from MF data
FRONTAGE: Length of front
DEPTH: Distance to cross when hit head on
NUMBER OF MINES: Total in minefield
ORIENTATION: Rotation about the axis
X,Y LOCATION: Center of minefield

3 LINE OBSTACLE BREACH:
"M"
SIDE:
MISSION NUMBER:
OBSTACLE TYPE: Type of line obstacle from the TB data
START OF THE SEG: Start of segment that is the obstacle
END OF THE SEGMENT: End of same segment
X,Y LOCATION: Location of breach

5 IMPROVE LINE BREACH:
"M"
SIDE:
MISSION NUMBER:
LINE BREACH TYPE: Type of line obstacle containing breach from TB data
START OF THE SEG: Start of obstacle segment
END OF THE SEGMENT: End of same segment
X,Y LOCATION: Location of breach

8 EMPLACE MINEFIELD:
"M"
SIDE:
MISSION NUMBER:
MINE TYPE: Minefield type from MF data
FRONTAGE: Length of front of minefield
DEPTH: Distance from front to back
NUMBER OF MINE: Total to be emplaced
ORIENTATION: Rotation about the axis
X,Y LOCATION: Center of minefield

9 EMPLACE LINE OBSTACLE:
"M"
SIDE:
MISSION NUMBER:
LINE OBSTACLE TYPE: From TB data
START OF THE OB: Beginning location of this segment of entire obstacle
END OF THE OBSTACLE: Ending location of this segment
FEATURE NUMBER: Identifies feature within mission

11 BRIDGE DEMOLITION:
"M"
SIDE:
MISSION NUMBER:
LINE BREACH TYPE: Feature type containing bridge
X,Y START: Beginning of the segment
X,Y END: End of the segment
X,Y LOCATION: Bridge location

12 PREPARE POSITION:
"M"
SIDE;
MISSION NUMBER;
DEF POSITION TYPE: Indicates type & min size of occupying unit
X,Y LOCATION: Position location
UNIT NAME: Name of requesting or occupying unit
COMPLETION FACTOR: Used in determining effect.

Obstacle complexes combine minefields and line obstacles. The information collected and reported about the individual features is slightly different than if they were not part of a complex. An obstacle complex mission can be completed as a whole or can be divided into separate jobs. For example, consider an obstacle complex that contains five anti-tank minefields, 10 directional mines, six barbed wire coils, and two tank ditches. This complex could be emplaced in one job with an emplace obstacle complex technique. A second method is to break the mission into four jobs. If the mission is not worked as a whole, there would be a minimum of four jobs, because different features must be worked separately; one for anti-tank minefields, one for directional mines, another for barbed wire, and the last for tank ditches. Another option is to further subdivide the tasks of any of the feature type into smaller missions. For example, the barbed wire coils can be divided into two jobs of three tasks each. Any such grouping of similar tasks is allowed. It depends on what the scenario developer determines is appropriate.

The BREACHER/EMPLACER MISSION NUMBER of the obstacle complex data in the MF data module is used to determine how to separate the jobs. If the mission is to be emplaced or breached as a whole, the BREACHER/EMPLACER MISSION NUMBER will be the same for all the features. Otherwise, the numbers will be the same only for the features that are to be grouped together in single efforts. In all cases, minefield and line obstacle features cannot be in the same job unless the obstacle complex is worked as a whole, in which case the individual features are not seen. When an obstacle complex mission is unassigned, the B/E MISSION NUMBER can give added insight into what went wrong. Technique, timing, equipment, and command chain data are still the areas to check for explanation. However, knowing how the mission was to be worked suggests whether to look at emplace/breach obstacle complex, minefield, or line obstacle data.

1 MINEFIELD BREACH:
"M"
SIDE:
MISSION NUMBER:
MINE TYPE: Minefield type
FRONTAGE: Frontage and depth together determine the size
DEPTH:
NUMBER OF MINES: Total number of this feature
COMPLETION PERCENT: Aides in determining the effect of the complex as a whole
BREACHER MS NUMBER: Determines how the feature is to be breached

3 LINE OBSTACLE BREACH:
"M"
SIDE:
MISSION NUMBER:
LINE OBSTACLE TYPE: Type of terrain barrier
FRONTAGE: Length of segment.
COMPLETION PERCENT: For determining effect
BREACHER MS NUMBER: Determines how the feature is to be breached

4 BREACH OBSTACLE COMPLEX:
"M"
SIDE:
MISSION NUMBER:
MINE TYPE: Minefield type
FRONTAGE: Frontage and depth together determine the size
DEPTH:
NUMBER OF MINES: Total number of this feature
COMPLETION PERCENT: Aides in determining the effect of the complex as a whole
BREACHER MS NUMBER: Determines how the feature is to be breached

8 EMPLACE MINEFIELD:
"M"
SIDE:
MISSION NUMBER:
MINE TYPE: Minefield type
FRONTAGE: Frontage and depth together determine the size
DEPTH:
NUMBER OF MINES: Total number of this feature
COMPLETION PERCENT: Aides in determining the effect of the complex as a whole
EMPLACER MS NUMBER: Determines how the feature is to be emplaced

9 EMPLACE LINE OBSTACLE:
"M"
SIDE:
MISSION NUMBER:
LINE OBSTACLE TYPE: Type of terrain barrier
FRONTAGE: Length of segment
COMPLETION PERCENT: For determining effect
EMPLACER MS NUMBER: Determines how the feature is to be emplaced

10 EMPLACE OBSTACLE COMPLEX:
"M"
SIDE:
MISSION NUMBER:
MINE TYPE: Minefield type
FRONTAGE: Frontage and depth together determine the size
DEPTH:
NUMBER OF MINES: Total number of this feature
COMPLETION PERCENT: Aides in determining the effect of the complex as a whole
EMPLACER MS NUMBER: Determine the feature is to be emplaced.

Table 9 contains examples of four unassigned mission records. The first record is a blue mission to improve a line breach. The job and asset records show that this mission was also to retrieve the original bridging asset. The mission was not canceled until the end of the simulation. This indicates the

technique, equipment, and personnel were present, although the latter two may not have been in the required tactical area in time.

The second record set is also a blue mission, to emplace a tank ditch that is part of obstacle complex 15, type COMPLEX3. In this complex, there are two minefields and a tank ditch that were emplaced by two engineer missions. The EMPLACER MISSION NUMBER is three, which indicates this mission is one of at least three missions. The complex needed to be emplaced by 00:02:00. Since this mission was canceled at that time, it can be assumed there was not enough time to complete the mission.

In the next unassigned mission records, red unit RENG1 requested the preparation of a defensive position. The mission was created at the beginning of the simulation but was not assigned within the required time.

The last unassigned mission is for a red unit to breach an obstacle complex containing a BATM3 minefield and a BDIRM minefield. The mission was canceled immediately after being created. This may have been due to one of many reasons: either no technique was available, or no unit with the correct equipment had the work site in its tactical area, or the work could not be finished by the requested time.

Table 9

Blue and Red Engineer Unassigned Missions

M	B/R	MISSION	TIME	TASK	ORG MS	LOCATION	START TIME	COMP TIME	NUM FEAT	UNIT	OC	OC NAME
M	1	9646872	2 0 0	5	0	573.245 -16.074	0 0 48	2 0 0	1	BENG2	0	
			FEATURE			SEGMENT START		SEGMENT END		BREACH POINT		
M	1	9646872	RIVER1			570.900 -17.700		577.100 -13.400		573.245 -16.074		
M	1	9742530	0 2 0	9	15	575.500 -10.750	0 0 0	0 2 0	1	-	15	COMPLEX3
			FEATURE			FRONTAGE		COMP	EMP MS NUM			
M	1	9742530	TANKDITCH			0.020		0.000	3			
M	2	9646960	0 12 0	12	0	543.000 -12.500	0 0 0	0 12 0	1	RENG1	0	
			FEATURE			LOCATION	COMP	UNIT				
M	2	9646960	SV/TNK			543.000 -12.500	0.0	12MR				
M	2	9722780	0 12 33	4	0	545.500 -21.900	0 12 33	0 19 33	2	21MR	0	COMPLEX2
			FEATURE			FRONT	DEPTH	MINES	COMP	BREACHER MS NUM		
M	2	9646780	BATM3			0.060	0.060	200.000	1.000	1		
M	2	9646780	BDIRM			0.040	0.040	10.000	1.000	1		

5 POSTPROCESSOR REPORTS.

Included here are the standard reports produced by the postprocessor from the data found in Appendix A and discussed in the previous section. Appendix B contains titles and headings of all the reports available through the postprocessor.

Summary Job Report by Unit and Summary Job Report by Task Type

These reports give a summary of the jobs (Figure 1). The first report displays each engineer headquarters unit, summarizing its jobs by task. The second report summarizes the jobs by task without the unit breakdown. In addition, it provides three other types of information that do not appear in the first report. The summary of each task includes the total number of jobs that were generated even if not assigned. This would include any jobs in the unassigned mission report. The total number of the jobs that are part of an obstacle complex is also included in this report. At the end of the report, a summary of the mine emplacements is included.

Detail Job Report by HQ Unit and Detail Job Report by Task Type

These reports list detailed information about each job (Figure 2). The jobs in the first report are in order by headquarters unit, then by task type. The jobs in the second are ordered by task type and then by headquarters. Because of the amount of information available, some attributes that appear on the first report do not appear on the next, and vice versa. The reason for canceling, the priority, the number of segments, and the last segment completed are reported in the first. The second contains location, size, assign time, and arrival time.

Task Performance with Organic Resources

Organic resources are those owned by a maneuver unit. This report (Figure 3) displays non-engineer activity. Not as much detail is possible with non-engineers, since it is used for a low resolution level of play.

Detail Breach Point Report

This report (Figure 4) displays the chronological activity relating to each breach point. The important fields to consider are the unit, the completion factor, and the flags. A new unit means that unit is responsible for destroying the breach point. The completion factor will decrease to 0.0 when the bridge is destroyed. The flags indicate the bridge has been prepared for demolition by the blue or red side. When a bridge has been destroyed, a new breach point is created if it is rebuilt. Typically, it is destroyed by one side and created by the other. To determine if this has happened, look at any breach point that has a time greater than the beginning of the simulation. Compare the location with any breaches that have been destroyed by the other side. The location does not have to be exact. In this scenario, two bridges were destroyed by the blue and two were built by the red after the start. Only one of the red bridges was rebuilt from a destroyed one.

SUMMARY JOB REPORT BY UNIT
BLUE

HQ UNIT	TASK	NUMBER ASSIGNED	NUMBER STARTED	NUMBER COMPLETED	AVERAGE JOB TIME	NUMBER DISCONTINUED	NUMBER IN PROGRESS
BENGHQ	BUILD CMBT	1	1	1	2.00	0	0
	REMOVE OB BREACH	1	1	1	0.25	0	0
BENG1	EMPLACE COMPLEX	1	1	1	0.50	0	0
	PREPARE POSITION	1	1	1	1.50	0	0
BENG2	BREACH OBSTACLE	1	1	1	0.25	0	0
	EMPLACE MINEFIELD	2	2	2	0.25	0	0
	EMPLACE OBSTACLE	1	1	1	0.40	0	0

SUMMARY JOB REPORT BY UNIT
RED

HQ UNIT	TASK	NUMBER ASSIGNED	NUMBER STARTED	NUMBER COMPLETED	AVERAGE JOB TIME	NUMBER DISCONTINUED	NUMBER IN PROGRESS
RENG1	BREACH MINEFIELD	2	2	2	0.13	0	0
	BREACH OBSTACLE	2	2	2	0.25	0	0
	IMPROVE OB BREACH	1	1	1	6.50	0	0

Figure 1. Summary Job Reports.

SUMMARY JOB REPORT BY TASK TYPE
SIDE

TASK NAME	NUMBER GENERATED	NUMBER ASSIGNED	NUMBER STARTED	NUMBER COMPLETED	AVERAGE JOB TIME	NUMBER DISCONTINUED	NUMBER IN PROGRESS	OBS COMP COMPLETED
BREACH OBSTACLE	1	1	1	1	0.75	0	0	0
BUILD CMBT	1	1	1	1	2.00	0	0	0
EMPLACE MINEFIELD	2	2	2	2	0.25	0	0	2
EMPLACE OBSTACLE	1	1	1	1	0.40	0	0	1
EMPLACE COMPLEX	2	1	1	1	0.50	0	0	1
REMOVE OB BREACH	1	1	1	1	0.25	0	0	0
PREPARE POSITION	1	1	1	1	1.50	0	0	0

MINE EMPLACEMENT TOTALS	TYPE	COUNT
	3	1000.00

SUMMARY JOB REPORT BY TASK TYPE
RED

NUMBER TASK NAME	NUMBER GENERATED	NUMBER ASSIGNED	NUMBER STARTED	AVERAGE COMPLETED	NUMBER JOB TIME	NUMBER DISCONTINUED	OBS COMP IN PROGRESS	COMPLETED
BREACH MINEFIELD	2	2	2	2	0.13	0	0	2
BREACH OBSTACLE	2	2	2	2	0.25	0	0	2
IMPROVE OB BREACH	1	1	1	1	6.50	0	0	0

MINE EMPLACEMENT TOTALS	TYPE	COUNT

Figure 1 (Cont'd).

DETAIL JOB REPORT BY HQ UNIT
BLUE

BLUE - BENGHQ

ORIG NBR	TASK	OBS COMP	RFQUESTING UNIT	START TIME	LATE FIN TIME	COMPLETE TIME	CANCEL TIME	CANCEL REASON	PRIORITY	TECH NBR	NBR SEG	LAST SEG
1	BUILD CMBT	0	132AR	0: 0: 0	1: 6: 0	0: 1:53			1242.000	12	1	1
0	REMOVE OB BREACH	0	CORPSFWD	0: 0: 0	2: 0: 0	0: 0:33			1762.333	18	1	1

BLUE - BENG1

ORIG NBR	TASK	OBS COMP	REQUESTING UNIT	START TIME	LATE FIN TIME	COMPLETE TIME	CANCEL TIME	CANCEL REASON	PRIORITY	TECH NBR	NBR SEG	LAST SEG
16	EMPLACE COMPLEX	16	-	0: 6: 0	2: 0: 0	0: 6:57			1738.500	17	1	1
0	PREPARE POSITION		111IN	0: 0: 0	2: 0: 0	0: 1:53			70.000	24	1	1

BLUE - BENG2

ORIG NBR	TASK	OBS COMP	REQUESTING UNIT	START TIME	LATE FIN TIME	COMPLETE TIME	CANCEL TIME	CANCEL REASON	PRIORITY	TECH NBR	NBR SEG	LAST SEG
0	BREACH OBSTACLE	0	121IN	0: 0:21	0: 5:57	0: 0:48			164.733	3	1	1
15	EMPLACE MINEFIELD	15	-	0: 0: 0	0: 2: 0	0: 1:19			1756.583	13	2	2
15	EMPLACE MINEFIELD	15	-	0: 0: 0	0: 2: 0	0: 1:49			1756.583	13	2	2
15	EMPLACE OBSTACLE	15	-	0: 0: 0	0: 2: 0	0: 1:51			1756.583	16	1	1

DETAIL JOB REPORT BY HQ UNIT
RED

RED - RENG1

ORIG NBR	TASK	OBS COMP	REQUESTING UNIT	START TIME	LATE FIN TIME	COMPLETE TIME	CANCEL TIME	CANCEL REASON	PRIORITY	TECH NBR	NBR SEG	LAST SEG
0	BREACH MINEFIELD	15	11MR	0:23: 0	1: 6: 0	0:23:35			2263.292	27	1	1
0	BREACH MINEFIELD	15	11MR	0:23: 0	1: 6: 0	0:23:43			2263.292	27	1	1
0	BREACH OBSTACLE	15	11MR	0:23: 0	1: 6: 0	0:23:43			2256.790	35	1	1
0	BREACH OBSTACLE	0	RENG1	0: 3:38	2: 0: 0	0: 0:37			166.273	31	1	1
0	IMPROVE OB BREACH	0	RENG1	0: 3:38	2: 0: 0	0: 8:52			2161.224	39	1	1

Figure 2. Detail Job Reports.

DETAIL JOB REPORT BY TASK TYPE
BLUE

BLUE - BREACH OBSTACLE

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME
0	121IN	BENG2	0: 0: 21	0: 5:57		3	573.245 -16.074	0.	0: 0:26	0: 0:33	0: 0:48	

BLUE - BUILD CMBT

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME
1	134AR	BENGHQ	0: 0: 0	1: 6: 0	0	12	549.000 -30.100	0.	0: 0: 0	0: 1:40	0: 1:53	

BLUE - EMPLACE MINEFIELD

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME
15	-	BENG2	0: 0: 0	0: 2: 0	15	13	575.500 -10.750	500.000	0: 0: 0	0: 0:49	0: 1:19	
15	-	BENG2	0: 0: 0	0: 2: 0	15	13	575.500 -10.750	500.000	0: 0: 0	0: 1:19	0: 1:49	

BLUE - EMPLACE OBSTACLE

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME
15	-	BENG2	0: 0: 0	0: 2: 0	15	16	575.500 -10.750	0.800	0: 0: 0	0: 1:27	0: 1:51	

BLUE - EMPLACE COMPLEX

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME

BLUE - REMOVE OB BREACH

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME

BLUE - PREPARE POSITION

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME
0	111IN	BENG1	0: 0: 0	2: 0: 0	0	12						

Figure 2. (Cont'd).

TASK PERFORMANCE WITH ORGANIC RESOURCES
BLUE

TIME	TASK	TECHNIQUE	UNIT	LOCATION		DURATION	EFFECT
0: 2:42	PREPARE POSITION	23	113AR	539.000	-12.000	0.510	1.000

TASK PERFORMANCE WITH ORGANIC RESOURCES
RED

TIME	TASK	TECHNIQUE	UNIT	LOCATION		DURATION	EFFECT
0:13:58	BREACH MINEFIELD	27	12MR	575.500	-10.750	0.100	1.000
0:13:59	BREACH MINEFIELD	27	12MR	575.500	-10.750	0.125	1.000
0:14: 2	BREACH OBSTACLE	35	12MR	575.500	-10.750	0.250	1.000
1:13:23	BREACH MINEFIELD	27	12MR	574.570	-24.000	0.100	1.000
1:13:26	BREACH MINEFIELD	27	12MR	574.570	-24.000	0.150	1.000
1:13:27	BREACH OBSTACLE	37	12MR	574.570	-24.000	0.500	1.000
1:13:27	BREACH OBSTACLE	35	12MR	574.570	-24.000	0.350	1.000

Figure 3. Task Performance With Organic Resources.

DETAIL BREACH POINT REPORT

BREACH POINT	LOCATION		TIME	UNIT	COMP FACTOR	BLUE FLAG	RED FLAG
9245456	569.000	-18.900	0: 0: 0	-	1.000	0	0
			0: 0: 0	122AR	1.000	0	0
			0: 0:36	122AR	1.000	1	0
			0: 3:10	122AR	0.000	1	0
9245520	578.650	-13.400	0: 0: 0	-	1.000	0	0
			0: 0:33	-	1.000	1	0
			0: 4: 0	CORPSFWD	0.000	1	0
9249488	569.050	-0.850	0: 0: 0	-	1.000	0	0
9249552	548.700	16.700	0: 0: 0	-	1.000	0	0
			0: 1: 0	CORPSFWD	0.000	0	0

DETAIL BREACH POINT REPORT

BREACH POINT	LOCATION		TIME	UNIT	COMP FACTOR	BLUE FLAG	RED FLAG
9194128	550.736	15.461	0: 3:38	-	1.000	0	0
9194064	578.576	-13.400	1: 0:37	-	1.000	0	0

Figure 4. Detail Breach Point Report.

Detail Combat Trails Report

This report (Figure 5) is a chronological listing of the building and use of combat trails. The time built is a real time, while the time involved is an quantity of time. The trafficability level is the level when the unit first became involved with the grid. If the level is less than the engineer effect, the unit is probably building the trail. The engineer effect indicates how much improvement (i.e., the increase in trafficability level) this type of trail will provide.

Detail Defensive Position Report by Side

This report (Figure 6) is also a chronological report that shows the use of defensive positions. The positions can be requested, built over time, occupied, and destroyed. They can be occupied by units of different prototypes if this is allowed in the input data for position prototypes. The last update shows the time when work on the position stopped. The first completion factor shows the value at the last update. The time occupied shows the amount of time the unit used the position. The next completion factor shows the value when the unit entered the position. A unit can enter the position before the work is completed or stopped. The exposure factor is not connected at this time. It will always read 1.000 for the occupying unit.

Summary of Assets by Unit and Summary of Assets by Type

These two reports (Figure 7) provide the same information organized in a different way. The first summarizes the asset types owned by each unit. The second summarizes each asset type. The total number of each asset type is given, followed by the averages for each one of those types.

Detail Report of Assets by Unit and Detail Report of Assets by Type

These two reports (Figure 8) provide the detailed information of each asset organized in a similar way as the summary reports. The first report lists each asset owned by the units. The second lists each asset of a given type.

Supply Deficits

This report (Figure 9) displays the instances of a lack of supplies for the engineer assets needed on a job. If the supply type is fuel or ammunition, the job was already assigned.

Detail Unassigned Mission Report by Side

This is a listing of all the missions not assigned during the simulation. The missions are listed by task type. Each task displays different information about the features in the mission, with different headings for each task type. Appendix B shows the headings for all the task types. If there are no missions in a task, that task is not listed. Sometimes an obstacle complex has been divided into more than one mission whose task may be breach/emplace minefield or breach/emplace obstacle. If one of those missions cannot be assigned, it will be reported under emplacing or breaching an obstacle complex. At the end of each task, the total number of missions in that task is listed.

DETAIL COMBAT TRAILS REPORT
BLUE

COMBAT TRAIL	LOCATION	VEG TYPE	GRID TRAFF	ENG EFFECT	TIME BUILT	UNIT	SIDE	TIME INVOLVED	TRAFF LEVEL
9119708	549.000 -228.000	*	0	2	0: 3:40	BENGHQ	1	0: 2: 0	0
						111IN	1	0:21:39	2
						132AR	1	0: 0:25	2

Figure 5. Detail Combat Trails Report.

DETAIL DEFENSIVE POSITION REPORT BY SIDE
BLUE

DEF POS ID	PROTO	LOCATION	REQUESTOR	LAST UPDATE	COMP FACTOR	TIME DESTROYED	OCCUPYING UNIT	PROTO	ARRIVA TIME	TIME OCCUPIED	COMP FACTOR	EXPOS FACTOR
8043232	2	548.000 -28.000	111IN	0: 0: 0	1.000		111IN	2	1: 2:45	0:21:15	1.000	1.000
8043336	2	541.000 -21.540	111IN	0: 1:53	1.000		111IN	2	0:12:58	0: 5: 2	1.000	1.000
8045228	3	536.580 -27.910	113AR	0: 3:22	1.000		-					
8045332	3	539.000 012.000	113AR	0: 2:42	1.000		113AR	3	0: 1:47	1:22:13	0.000	1.000

DETAIL DEFENSIVE POSITION REPORT BY SIDE
RED

DEF POS ID	PROTO	LOCATION	REQUESTOR	LAST UPDATE	COMP FACTOR	TIME DESTROYED	OCCUPYING UNIT	PROTO	ARRIVAL TIME	TIME OCCUPIED	COMP FACTOR	EXPOS FACTOR
8074160	1	544.000 -33.000	RENG2	1: 8: 0	1.000		RENG2	1	0: 2: 5	0:22:55		0.0001.000

Figure 6. Detail Defensive Position Report by Side.

SUMMARY OF ASSETS BY UNIT
SIDE

SIDE - UNIT NAME

ASSET NAME	NBR ASSETS	AVG NBR JOBS	AVG AVAIL TIME	AVG PREP TIME	AVG TRAVEL TIME	AVG WAIT TIME	AVG WORK TIME	AVG REST TIME	AVE DAMAGED TIME	AVE AT SITE TIME	AVG UNDAMAGED PORTION	NBR DAMAGED	AVG DISTANCE TRAVEL'D

****

SUMMARY REPORT FOR ASSETS BY TYPE
SIDE

ASSET NAME	NBR ASSETS	AVG NBR JOBS	AVG AVAIL TIME	AVG PREP TIME	AVG TRAVEL TIME	AVG WAIT TIME	AVG WORK TIME	AVG REST TIME	AVE DAMAGED TIME	AVE AT SITE TIME	AVG UNDAMAGED PORTION	NBR DAMAGED	AVG DISTANCE TRAVEL'D

Figure 7. Summary of Assets by Unit.

DETAIL REPORT OF ASSETS BY UNIT
SIDE

SIDE - HQ NAME

TYPE	ASSET ID	NBR JOBS	AVAIL TIME	PREP TIME	TRAVEL TIME	WAIT TIME	WORK TIME	REST TIME	DAMAGED TIME	AT SITE TIME	UNDAMAGED PORTION	DISTANCE TRAVEL'D

****

DETAIL REPORT OF ASSETS BY TYPE
SIDE

OWNING HQ UNIT	ASSET ID	NBR JOBS	AVAIL TIME	PREP TIME	TRAVEL TIME	WAIT TIME	WORK TIME	REST TIME	DAMAGED TIME	AT SITE TIME	UNDAMAGED PORTION	DISTANCE TRAVEL'D

SIDE - ASSET NAME

Figure 8. Detail Report of Assets by Unit.

SUPPLY DEFICITS
BLUE

TRANSFER TIME	UNIT	SUPPLY TYPE	AMOUNT NEEDED	AMOUNT ON HAND
0: 0:30	BENG2	BATM1	10.5	9.5
0: 0:57	BENG2	WIRE	50.0	25.0
0:16: 7	ENGR_WT170	FUEL	100.0	30.0

Figure 9. Supply Deficits.

DETAIL UNASSIGNED MISSION REPORT BY SIDE
BLUE

BLUE - IMPROVE OB BREACH

ORIG NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	FEATURE	SEGMENT START LOCATION	SEGMENT END LOCATION	BRIDGE/BREACH LOCATION
0	2: 0: 0	BENG2	0: 0:48	2: 0: 0	RIVER1	570.900 -17.700	577.100 -13.400	573.245 -16.074

1 Mission

SIDE - EMPLACE COMPLEX

COMP NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	LOCATION	FEATURE	FRONTAGE	DEPTH	NBR MINES	% COMPLETE	MS NUM
15	0: 2: 0	-	0: 0: 0	0: 2: 0	575.500 -10.750	TANKDITCH	0.020			0.000	3

1 Mission

DETAIL UNASSIGNED MISSION REPORT BY SIDE
RED

RED - PREPARE POSITION

ORIG NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	POSITION TYPE	LOCATION
0	0:12: 0	RENG1	0: 0: 0	0:12: 0	SV/TNK	543.000 -12.500

1 Mission

RED - BREACH COMPLEX

COMP NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	LOCATION	FEATURE	FRONTAGE	DEPTH	NBR MINES	% COMPLETE	MS NUM
16	0:12:33	21MR	0:12:33	0:19:33	545.500 -21.900	BATM3	0.069	0.060	.200	1.000	1
						BDIRM	0.040	0.040	.010	1.000	1

1 Mission

Figure 10. Detail Unassigned Mission Report by Side.

6 DATABASE FILES

The Engineer Postprocessor program creates ASCII files for use by a database management system. These files contain a copy of the data structure found in the postprocessor, plus a prefix that identifies the scenario. This prefix allows for comparisons between scenarios. These files were created to be used with INGRES, a relational database management system used by Fort Leavenworth. Since Ingres refers to its file structure as tables, these files will be discussed as tables. The DOS filename for each file is the scenario prefix plus a two- letter abbreviation of the table name with ".ing" as the extension. A complete listing of the data items and structure for each file can be found in Appendix C.

System Table

The System Table contains the data from the Engineer Setup file and other scenario-identifying information.

Side Table

Non-engineer missions, logistics records, defensive position and combat trails are kept in sets according to the owning side. The side names and the number of records in each of these sets per side are kept in this table.

Task Table

The task name and the number of assigned and unassigned missions for each task are kept here.

HQ Table

For each headquarters, the name, side, and number of entries in its inventory and mission list sets are recorded in this table.

Asset Proto Table

The name and number of assets of each prototype are in this table.

Asset Table

The basic information about each asset is in this table.

Asset Time Table

For each asset, this tables contains the time the asset was involved in the eight status positions: available, pre-task, in transit, waiting, working, in rest period, damaged, and left at site.

Asset Job Table

This table identifies the missions with which each asset was involved.

Mission Table

This table contains the unique information about each mission.

Job Table

The basic job data is contained in this table.

Job_Time Table

This table contains the timing information kept for jobs: assignment, activation, completion, and discontinue.

Job_Segment Table

This table contains the data on the segments of each job.

Non Engineer Table

Information relating to non-engineer jobs is stored here.

Breach Point Table

All information recorded about breach points is in this table.

Defensive Position Table

The basic data about the defensive position itself is found here.

Defensive Position Occupying Unit Table

For each defensive position, this table contains data about the units that occupy that position.

Combat Trail Table

The basic data about each combat trail is found here.

Trail Using Unit Table

For each trail, this tables contains information about each unit using the trail.

Logistics Transfer Table

Information about transfer of engineer supplies is kept here.

Unassigned Mission Table

The unique data about each unassigned mission is kept in this table. Information about each feature of the mission is kept in tables according to the mission task:

Minefield Feature Table:	Minefield Breach, Minefield Clear, Emplace Minefield
Breach Feature Table:	Line Obstacle Breach, Improve Line Breach, Bridge Demolition
Obstacle Feature Table:	Emplace Line Obstacle
Position Feature Table:	Prepare Position
Trail Feature Table:	Build Trail
Road Feature Table:	Repair Road Crater, Crater Road, Maintain Road
Obstacle Complex Feature Table:	Breach Obstacle Complex, Emplace Obstacle Complex

7 RECOMMENDATIONS

Combining the engineer history output file, the postprocessor reports, and the database files gives a great deal of flexibility in analyzing engineer activity for a given run of the simulation. The standard reports and the database files provide a considerable amount of data about engineer job processing, resource allocation and use, and workload distribution. Other areas need to be explored to realize the full potential of the information to be gathered from the enhanced engineer representation in VIC.

Some areas involving engineers are not tracked as closely by the engineer module as others, including: minefields, obstacle complexes, line features, attrition, and logistics. These are monitored in their own modules (obstacle complexes being a part of minefields) with separate output files created. No method has been developed for tracking cause-and-effect relationships to measure the contribution of the combat engineer effort. For example certain questions remain unanswered: "Did a minefield emplaced by engineers hinder the enemy in any way? If so, how and to what degree?" The output files for these modules contain tables and other information not readable by the VIC postprocessor. An INGRES translator has been developed to translate these files into useable information. A similar tool is needed for accessing the data useful to engineers. The data obtained from an engineer translator can be combined with the information in the ASCII database files to enhance development in other directions.

The development of a database management system for engineer analysis is another direction to explore. A complete and user-friendly system making use of the ASCII database files would allow studies to be examined simply and quickly. It could also facilitate the training of personnel in performing model studies and developing data.

Another direction to pursue is the development of a graphical playback program for the engineer module. This would give a visual representation of the engineer activity in VIC that would show the actual execution of the model. The engineer-specific playback feature should be built to concentrate on the crucial elements of interest to the engineer analysts. The VIC postprocessor already has a sophisticated playback capability, but it contains no engineer representation. Working with the personnel at Fort Leavenworth to capture the engineer effort for VIC would enhance the knowledge of both the engineer scenario developer and the VIC scenario developer.

APPENDIX A:

Unsorted and Sorted Engineer History File

UNSORTED ENGINEER HISTORY FILE

```
T 1          9119708  0  0  0  1                0      549.000  -28.000      *
B 0          9245456  0  0  0     0  0             0  569.000  -18.900      1.000                          -
B 0          9245520  0  0  0     0  0             0  578.650  -13.400      1.000                          -
B 0          9249488  0  0  0     0  0             0  569.050   -0.850      1.000                          -
B 0          9249552  0  0  0     0  0             0  548.700   16.700      1.000                          -
B 1          9245456  0  0  0     0  0             0  569.000  -18.900      1.000                          -
B 1          9245520  0  0  0     0  0             0  578.650  -13.400      1.000                          -
D 1          8043232  0  0  0  1        2           0  548.000  -28.000      1.000     1.000                111IN
D 1          8043336  0  0  0  1           2        0  541.100  -21.540      0.500     1.000                111IN
D 1          8045228  0  0  0  1           3        0  536.580  -27.910      0.        1.000                113AR
D 1          8045332  0  0  0  1           3        0  539.000  -12.000      0.        1.000                113AR
D 2          8074160  0  0  0  1           1        0  544.000  -33.000      0.        1.000                RENG2
A 1          9511016  0  0  0  1              4     0  543.000  -44.000      1.000     0                 0  BENGHQ
A 1          9511236  0  0  0  1              6     0  543.000  -44.000      1.000     0                 0  BENGHQ
A 1          9659160  0  0  0  1              4     0  540.490  -16.870      1.000     0                 0    BENG1
A 1          9659584  0  0  0  1              6     0  540.490  -16.870      1.000     0                 0    BENG1
A 1          9659628  0  0  0  1              6     0  540.490  -16.870      1.000     0                 0  BENG1
A 1          9660272  0  0  0  1              2     0  574.600  -15.910      1.000     0                 0  BENG2
A 1          9661252  0  0  0  1              4     0  574.600  -15.910      1.000     0                 0  BENG2
A 1          9661632  0  0  0  1              5     0  574.600  -15.910      1.000     0                 0  BENG2
A 2          9665948  0  0  0  1             10     0  582.180    6.660      1.000     0                 0  RENG1
J 1    1     9261072  0  0  0  1 12  2       24     2  541.100  -21.540      0.        0  0  0  2  0  0  111IN                0    0
J 1    1     9261072  0  0  0  2             24        70.000    1           1
A 1          9659584  0  0  0  2              6        540.490  -16.870      1.000     1           9261072  ENGR_WT170
A 1          9659584  0  0  0  3              6        540.490  -16.870      1.000     1           926107   ENGR_WT170
A 1          9659628  0  0  0  2              6        540.490  -16.870      1.000     1           9261072  ENGR_WT170
A 1          9659628  0  0  0  3              6        540.490  -16.870      1.000     1           9261072  ENGR_WT170
J 1   10     9739420  0  0  0  1  7  3        12     1  549.000  -30.100      0.        0  0  0  1  6  0  132AR                1    0
J 1   10     9739420  0  0  0  2             12       1242.000    1           1
A 1          9511236  0  0  0  2              6        543.000  -44.000      1.000    10           9739420  ENGR_WT175
A 1          9511236  0  0  0  3              6        543.000  -44.000      1.000    10           9739420  ENGR_WT175
J 1   13     9740584  0  0  0  1  8  3        13     3  575.500  -10.750    500.000  0  0  0  0  2  0  -                   15   15 COMPLEX3
J 1   13     9740584  0  0  0  2             13       1756.583    1           2
A 1          9661252  0  0  0  2              4        574.600  -15.910      1.000    13           9740584  ENGR_WT179
A 1          9661252  0  0  0  3              4        574.600  -15.910      1.000    13           9740584  ENGR_WT179
J 1   13     9740816  0  0  0  1  8  3        13     3  575.500  -10.750    500.000  0  0  0  0  2  0  -                   15   15 COMPLEX3
J 1   14     9741608  0  0  0  1  9  3        16     3  575.500  -10.750      0.800  0  0  0  0  2  0  -                   15   15 COMPLEX3
A 1          9661632  0  0  0  2              5        574.600  -15.910      1.000    14           9741608  ENGR_WT180
A 1          9661632  0  0  0  3              5        575.500  -10.750      1.000    14           9741608  ENGR_WT180
J 1   21     9742632  0  0  0  1 11  1        18     3  578.650  -13.400      0.        0  0  0  2  0  0  CORPSFWD             0    0
J 1   21     9742632  0  0  5  2             18       1762.333    1           1
A 1          9661252  0  0  5  3              4        574.600  -15.910      1.000    13           9740584  ENGR_WT179
J 1   21     9742632  0  0 18  3              1     0  1
J 1   22     9742632  0  0 21  1  3  1        3     3  573.245  -16.074      0.        0  0 21  0  5 57  121IN               0    0
J 1    1     9261072  0  0 23  3              1     2  1
A 1          9659628  0  0 23  5              6        541.100  -21.540      1.000     1           9261072  ENGR_WT170
J 1   22     9742632  0  0 26  2              3       164.733    1           1
A 1          9660272  0  0 26  2              2        573.066  -18.513      1.000    22           9742632  ENGR_WT186
A 1          9660272  0  0 26  3              2        573.066  -18.513      1.000    22           9742632  ENGR_WT186
L 1   BENG2           0  0 30  BATM1                 10.0      9.5
J 1   21     9742632  0  0 33  5              1
J 1   21     9742632  0  0 33  6              1
B 1          9245520  0  0 33     1  0              578.650  -13.400      1.000                          -
J 1   21     9742632  0  0 33  7                     0.
J 1   21     9742632  0  0 33  8
```

UNSORTED ENGINEER HISTORY FILE (Cont'd)

```
J 1   22       9742632  0  0 33  3          1    2  1
A 1            9660272  0  0 33  5           2      573.245  -16.074     1.000   22       9742632 ENGR_WT186
B 1            9245456  0  0 36     1  0             569.000  -18.900     1.000                    122AR
J 1   22       9742632  0  0 48  5          1
A 1            9660272  0  0 48  8           2      573.245  -16.074     1.000    0           0 ENGR_WT186
J 1   22       9742632  0  0 48  6          1
J 1   22       9742632  0  0 48  7                   0.
J 1   22       9742632  0  0 48  8
J 1   13       9740584  0  0 49  3          1    0  1
A 1            9661252  0  0 49  5           4      575.500  -10.750     1.000   13       9740584 ENGR_WT179
L 1   BENG2             0  0 57 WIRE                50.0     25.0
B 1            9249552  0  1  0     0  0             548.700   16.700     0.                       CORPSFWD
J 1   13       9740584  0  1  4  3          2    2  1
A 1            9661252  0  1  4  5           4      575.500  -10.750     1.000   13       9740584 ENGR_WT179
J 1   13       9740584  0  1  4  5          1
J 1   13       9740584  0  1 19  5          2
J 1   13       9740584  0  1 19  6          2
A 1            9661252  0  1 19  3           4      575.500  -10.750     1.000   13       9740816 ENGR_WT179
J 1   13       9740584  0  1 19  7                   0.
J 1   13       9740816  0  1 19  3          1    0  1
A 1            9661252  0  1 19  5           4      575.500  -10.750     1.000   13       9740816 ENGR_WT179
J 1   14       9741608  0  1 27  3          1    2  1
A 1            9661632  0  1 27  5           5      575.500  -10.750     1.000   14       9741608 ENGR_WT180
J 1   13       9740816  0  1 34  3          2    2  1
A 1            9661252  0  1 34  5           4      575.500  -10.750     1.000   13       9740816 ENGR_WT179
J 1   13       9740816  0  1 34  5          1
J 1   10       9739420  0  1 40  3          1    2  1
D 1            8045332  0  1 47  3        3        539.000  -12.000     0.       1.000           113AR
J 1   13       9740816  0  1 49  5          2
J 1   13       9740816  0  1 49  6          2
A 1            9661252  0  1 49  3           4      567.769  -31.257     1.000    0           0 ENGR_WT179
J 1   13       9740816  0  1 49  7                   0.
J 1   13       9740816  0  1 49  8
J 1   14       9741608  0  1 51  5          1
J 1   14       9741608  0  1 51  6          1
A 1            9661632  0  1 51  3           5      575.500  -10.750     1.000    0           0 ENGR_WT180
J 1   14       9741608  0  1 51  7                   0.
J 1   14       9741608  0  1 51  8
J 1    1       9261072  0  1 53  5        1
J 1    1       9261072  0  1 53  6        1
A 1            9659584  0  1 53  3           6       541.100  -21.540     1.000    0           0 ENGR_WT170
A 1            9659628  0  1 53  3           6       541.100  -21.540     1.000    0           0 ENGR_WT170
J 1    1       9261072  0  1 53  7                   0.
J 1    1       9261072  0  1 53  8
D 1            8043336  0  1 53  2        2        541.100  -21.540     1.000    1.000           111IN
A 1            9661252  0  1 59  1           4      565.890  -45.670     1.000    0           0 BENG2
D 1            8045332  0  2  0  2        3        539.000  -12.000     0.647    1.000           113AR
M 1            9742530  0  2  0     9   15        575.500  -10.750   0  0  0  0  2  0      1 -                    15 COMPLEX3
M 1            9742530 TANKDITCH          0.020                                          0.000          3
D 1            8045332  0  2 15  2        3        539.000  -12.000     0.772    1.000           113AR
A 1            9659584  0  2 17  1           6      540.490  -16.870     1.000    0           0 BENG1
A 1            9659628  0  2 17  1           6      540.490  -16.870     1.000    0           0 BENG1
D 1            8045332  0  2 30  2        3        539.000  -12.000     0.897    1.000           113AR
D 1            8045332  0  2 42  2        3        539.000  -12.000     1.000    1.000           113AR
N 1   113AR             0  2 42    12  1  23  539.000  -12.000     0.510    1.000
B 1            9245456  0  3 10     1  0             569.000  -18.900     0.                       122AR
```

UNSORTED ENGINEER HISTORY FILE (Cont'd)

```
D 1          8045228  0  3 22  2       3        536.580  -27.910     1.000     1.000          113AR
B 2          9194128  0  3 38     0  0           550.736   15.461     1.000                    -
J 1  10      9739420  0  3 40  5         1
J 1  10      9739420  0  3 40  6         1
T 1          9119708  0  3 40    2  2         549.000  -30.100 BENGHQ
J 1  10      9739420  0  3 40  7                  0.
J 1  10      9739420  0  3 40  8
A 1          9661632  0  3 54  3          5       569.580  -24.686     1.000     0            0 ENGR_WT180
J 1  33      8044188  0  4  0  1 10  2   17   2  545.500  -21.900     0.     0  6  0  2  0  0 -                  16  16 COMPLEX2
B 1          9245520  0  4  0     0  0           578.650  -13.400     0.                        CORPSFWD
A 1          9661632  0  5 22  3          5       567.384  -34.214     1.000     0            0 ENGR_WT180
J 1  33      8044188  0  6  0  2        17      1738.500    1          1
A 1          9659160  0  6  0  2          4       540.490  -16.870     1.000    33      8044188 ENGR_WT196
A 1          9659160  0  6  0  3          4       540.490  -16.870     1.000    33      8044188 ENGR_WT196
J 1  33      8044188  0  6 27  3          1    0  1
A 1          9659160  0  6 27  5          4       545.500  -21.900     1.000    33      8044188 ENGR_WT196
A 1          9661632  0  6 34  1          5       565.890  -45.670     1.000     0            0 BENG2
J 1  33      8044188  0  6 57  5          1
J 1  33      8044188  0  6 57  6          1
A 1          9659160  0  6 57  3          4     545.500  -21.900       1.000     0            0 ENGR_WT196
J 1  33      8044188  0  6 57  7                  0.
J 1  33      8044188  0  6 57  8
A 1          9659160  0  7 25  1          4     540.490  -16.870       1.000     0            0 BENG1
M 2          9646960  0 12  0    12     0         543.000  -12.500   0  0  0  0 12  0        1 RENG1              0
M 2          9646960 SV/TNK                   543.000       -12.500          0.0                 12MR
M 2          9722780  0 12 33     4     0         545.500  -21.900   0 12 33  0 19 33        2 21MR               0
M 2          9646780 BATM3                     0.060          0.060         200.000      1.000         1
M 2          9646780 BDIRM                     0.040          0.040          10.000      1.000         1
D 1          8043336  0 12 58  3        2        541.100  -21.540     1.000     1.000          111IN
N 2  12MR             0 13 58     1  1  27  575.500  -10.750     0.100     1.000
N 2  12MR             0 13 59     1  1  27  575.500  -10.750     0.125     1.000
N 2  12MR             0 14  2     3  5  35  575.500  -10.750     0.250     1.000
L 1  ENGR_WT170       0 16  7 FUEL             100.0      30.0
D 1          8043336  0 18  0  4        2        541.100  -21.540     1.000     1.000          111IN
J 2  44      9261072  0 23  0  1  1  3   27   4  575.500  -10.750     0.250  0 23  0  1  6  0 11MR               0  15 COMPLEX3
J 2  44      9261352  0 23  0  1  1  3   27   4  575.500  -10.750     0.250  0 23  0  1  6  0    11MR            0  15 COMPLEX3
J 2  45      9813008  0 23  0  1  3  3   35   4  575.500  -10.750     0.     0 23  0  1  6  0    11MR            0  15 COMPLEX3
J 2  44      9261072  0 23  5  2        27      2263.292    1          1
J 2  45      9813008  0 23  5  2        35      2256.790    1          1
J 2  44      9261072  0 23 28  3          1    2  1
J 2  45      9813008  0 23 28  3          1    0  1
J 2  44      9261072  0 23 35  5          1
J 2  44      9261072  0 23 35  6          1
J 2  44      9261072  0 23 35  7                  0.
J 2  44      9261352  0 23 35  3          1    2  1
J 2  44      9261352  0 23 43  5          1
J 2  44      9261352  0 23 43  6          1
J 2  44      9261352  0 23 43  7                  0.
J 2  44      9261352  0 23 43  8
J 2  45      9813008  0 23 43  5          1
J 2  45      9813008  0 23 43  6          1
J 2  45      9813008  0 23 43  7                  0.
J 2  45      9813008  0 23 43  8
J 2  46      9261352  1  0 16  1  3  1   31   5  578.576  -13.400     0.     0  3 38  2  0  0    RENG1           0   0
A 2          9665948  1  0 16  2          10      579.670  -12.590     1.000    46      9261352 ENGR_WT195
J 2  46      9261352  1  0 17  2        31      166.273    1          1
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UNSORTED ENGINEER HISTORY FILE (Cont'd)

```
A 2          9665948  1  0 17  3          10      579.670  -12.590      1.000   46      9261352 ENGR_WT195
J 2  46      9261352  1  0 22  3          1    2   1
A 2          9665948  1  0 22  5          10      578.576  -13.400      1.000   46      9261352 ENGR_WT195
J 2  46      9261352  1  0 37  5          1
A 2          9665948  1  0 37  8          10      578.576  -13.400      1.000    0            0 RENG1
J 2  46      9261352  1  0 37  6          1
B 2          9194064  1  0 37     0  0             578.576  -13.400      1.000                   -
J 2  46      9261352  1  0 37  7                   0.
J 2  46      9261352  1  0 37  8
J 2  47      9743376  1  0 37  1  5  4   39   5  578.576  -13.400      0.      0  3 38  2  0  0    RENG1          0    0
J 2  47      9743376  1  0 42  2        39     1261.224    1          1
D 2          8074160  1  2  5  3        1         544.000  -33.000      0.        1.000          RENG2
T 1          9119708  1  2 21     3  2          547.000  -27.209 111IN
J 2  47      9743376  1  2 22  3          1    0   1
D 1          8043232  1  2 45  3        2         548.000  -28.000      1.000     1.000          111IN
T 1          9119708  1  6  0     3  2          549.485  -26.001 132AR
T 1          9119708  1  6 25     4  4          550.475  -30.003 132AR
D 2          8074160  1  8  0  2        1         544.000  -33.000      1.000     1.000          RENG2
N 2  RENG2            1  8  0     12  1  50  544.000  -33.000      4.000     1.000
J 2  47      9743376  1  8 52  5          1
J 2  47      9743376  1  8 52  6          1
A 2          9665948  1  8 52  3          10      579.670  -12.590      1.000   47      9743376 ENGR_WT177
J 2  47      9743376  1  8 52  7                   0.
J 2  47      9743376  1  8 52  8
A 2          9665948  1  9 15  1          10      582.180    6.660      1.000    0            0 RENG1
N 2  12MR             1 13 23     1  1  27  574.575  -24.000      0.100     1.000
N 2  12MR             1 13 26     1  1  27  574.575  -24.000      0.150     1.000
N 2  12MR             1 13 27     3  1  37  570.325  -22.000      0.500     1.000
N 2  12MR             1 13 27     3  5  35  574.575  -24.000      0.350     1.000
M 1          9646872  2  0  0     5     0        573.245  -16.074   0  0 48  2  0  0        1 BENG2              0
M 1          9646872 R1VER1                570.900       -17.700        577.100      -13.400       573.245    -16.074
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SORTED ENGINEER HISTORY FILE

```
A 1          9511016  0  0  0  1          4       543.000  -44.000      1.000    0            0 BENGHQ
A 1          9511236  0  0  0  1          6       543.000  -44.000      1.000    0            0 BENGHQ
A 1          9511236  0  0  0  2          6       543.000  -44.000      1.000   10      9739420 ENGR_WT175
A 1          9511236  0  0  0  3          6       543.000  -44.000      1.000   10      9739420 ENGR_WT175
A 1          9511236  0  1 40  5          6       549.000  -30.100      1.000   10      9739420 ENGR_WT175
A 1          9511236  0  3 40  3          6       549.000  -30.100      1.000    0            0 ENGR_WT175
A 1          9511236  0  4  0  3          6       547.529  -33.507      1.000    8      8044328 ENGR_WT188
A 1          9511236  0  5 20  3          6       543.000  -44.000      1.000    8      8044328 ENGR_WT188
A 1          9511236  0  6 33  5          6       555.000  -40.000      1.000    8      8044328 ENGR_WT188
A 1          9511236  0  9 33  3          6       555.000  -40.000      1.000    0            0 ENGR_WT188
A 1          9511236  0  9 46  1          6       543.000  -44.000      1.000    0            0 BENGHQ
A 1          9659160  0  0  0  1          4       540.490  -16.870      1.000    0            0 BENG1
A 1          9659160  0  6  0  2          4       540.490  -16.870      1.000   33      8044188 ENGR_WT196
A 1          9659160  0  6  0  3          4       540.490  -16.870      1.000   33      8044188 ENGR_WT196
A 1          9659160  0  6 27  5          4       545.500  -21.900      1.000   33      8044188 ENGR_WT196
A 1          9659160  0  6 57  3          4       545.500  -21.900      1.000    0            0 ENGR_WT196
A 1          9659160  0  7 25  1          4       540.490  -16.870      1.000    0            0 BENG1
A 1          9659584  0  0  0  1          6       540.490  -16.870      1.000    0            0 BENG1
A 1          9659584  0  0  0  2          6       540.490  -16.870      1.000    1      9261072 ENGR_WT170
A 1          9659584  0  0  0  3          6       540.490  -16.870      1.000    1      9261072 ENGR_WT170
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SORTED ENGINEER HISTORY FILE (Cont'd)

A	1	9659584	0	0	23	5		6	541.100	-21.540	1.000	1	9261072 ENGR_WT170
A	1	9659584	0	1	53	3		6	541.100	-21.540	1.000	0	0 ENGR_WT170
A	1	9659584	0	2	17	1		6	540.490	-16.870	1.000	0	0 BENG1
A	1	9659628	0	0	0	1		6	540.490	-16.870	1.000	0	0 BENG1
A	1	9659628	0	0	0	2		6	540.490	-16.870	1.000	1	9261072 ENGR_WT170
A	1	9659628	0	0	0	3		6	540.490	-16.870	1.000	1	9261072 ENGR_WT170
A	1	9659628	0	0	23	5		6	541.100	-21.540	1.000	1	9261072 ENGR_WT170
A	1	9659628	0	1	53	3		6	541.100	-21.540	1.000	0	0 ENGR_WT170
A	1	9659628	0	2	17	1		6	540.490	-16.870	1.000	0	0 BENG1
A	1	9660272	0	0	0	1		2	574.600	-15.910	1.000	0	0 BENG2
A	1	9660272	0	0	26	2		2	573.066	-18.513	1.000	22	9742632 ENGR_WT186
A	1	9660272	0	0	26	3		2	573.066	-18.513	1.000	22	9742632 ENGR_WT186
A	1	9660272	0	0	33	5		2	573.245	-16.074	1.000	22	9742632 ENGR_WT186
A	1	9660272	0	0	48	8		2	573.245	-16.074	1.000	0	0 ENGR_WT186
A	1	9661252	0	0	0	1		4	574.600	-15.910	1.000	0	0 BENG2
A	1	9661252	0	0	0	2		4	574.600	-15.910	1.000	13	9740584 ENGR_WT179
A	1	9661252	0	0	0	3		4	574.600	-15.910	1.000	13	9740584 ENGR_WT179
A	1	9661252	0	0	5	3		4	574.600	-15.910	1.000	13	9740584 ENGR_WT179
A	1	9661252	0	0	49	5		4	575.500	-10.750	1.000	13	9740584 ENGR_WT179
A	1	9661252	0	1	4	5		4	575.500	-10.750	1.000	13	9740584 ENGR_WT179
A	1	9661252	0	1	19	3		4	575.500	-10.750	1.000	13	9740816 ENGR_WT179
A	1	9661252	0	1	19	5		4	575.500	-10.750	1.000	13	9740816 ENGR_WT179
A	1	9661252	0	1	34	5		4	575.500	-10.750	1.000	13	9740816 ENGR_WT179
A	1	9661252	0	1	49	3		4	567.769	-31.257	1.000	0	0 ENGR_WT179
A	1	9661252	0	1	59	1		4	565.890	-45.670	1.000	0	0 BENG2
A	1	9661632	0	0	0	1		5	574.600	-15.910	1.000	0	0 BENG2
A	1	9661632	0	0	0	2		5	574.600	-15.910	1.000	14	9741608 ENGR_WT180
A	1	9661632	0	0	0	3		5	575.500	-10.750	1.000	14	9741608 ENGR_WT180
A	1	9661632	0	1	27	5		5	575.500	-10.750	1.000	14	9741608 ENGR_WT180
A	1	9661632	0	1	51	3		5	575.500	-10.750	1.000	0	0 ENGR_WT180
A	1	9661632	0	3	54	3		5	569.580	-24.686	1.000	0	0 ENGR_WT180
A	1	9661632	0	5	22	3		5	567.384	-34.214	1.000	0	0 ENGR_WT180
A	1	9661632	0	6	34	1		5	565.890	-45.670	1.000	0	0 BENG2
A	2	9665948	0	0	0	1		10	582.180	6.660	1.000	0	0 RENG1
A	2	9665948	1	0	16	2		10	579.670	-12.590	1.000	46	9261352 ENGR_WT195
A	2	9665948	1	0	17	3		10	579.670	-12.590	1.000	46	9261352 ENGR_WT195
A	2	9665948	1	0	22	5		10	578.576	-13.400	1.000	46	9261352 ENGR_WT195
A	2	9665948	1	0	37	8		10	578.576	-13.400	1.000	0	0 RENG1
A	2	9665948	1	8	52	3		10	579.670	-12.590	1.000	47	9743376 ENGR_WT177
A	2	9665948	1	9	15	1		10	582.180	6.660	1.000	0	0 RENG1
B	0	9245456	0	0	0	0	0		569.000	-18.900	1.000		-
B	0	9245520	0	0	0	0	0		578.650	-13.400	1.000		-
B	0	9249488	0	0	0	0	0		569.050	-0.850	1.000		-
B	0	9249552	0	0	0	0	0		548.700	16.700	1.000		-
B	1	9245456	0	0	0	0	0		569.000	-18.900	1.000		-
B	1	9245456	0	0	0	0	0		569.000	-18.900	1.000		122AR
B	1	9245456	0	0	36	1	0		569.000	-18.900	1.000		122AR
B	1	9245456	0	3	10	1	0		569.000	-18.900	0.		122AR
B	1	9245520	0	0	0	0	0		578.650	-13.400	1.000		-
B	1	9245520	0	0	33	1	0		578.650	-13.400	1.000		-
B	1	9245520	0	4	0	0	0		578.650	-13.400	0.		CORPSFWD
B	1	9249552	0	1	0	0	0		548.700	16.700	0.		CORPSFWD
B	2	9194128	0	3	38	0	0		550.736	15.461	1.000		-
B	2	9194064	1	0	37	0	0		578.576	-13.400	1.000		-
D	1	8043232	0	0	0	1	2		548.000	-28.000	1.000	1.000	111IN
D	1	8043232	1	2	45	3	2		548.000	-28.000	1.000	1.000	111IN

SORTED ENGINEER HISTORY FILE (Cont'd)

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D 1          8043336  0  0  0  1        2          541.100  -21.540    0.500     1.000          111IN
D 1          8043336  0  1 53  2        2          541.100  -21.540    1.000     1.000          111IN
D 1          8043336  0 12 58  3        2          541.100  -21.540    1.000     1.000          111IN
D 1          8043336  0 18  0  4        2          541.100  -21.540    1.000     1.000          111IN
D 1          8045228  0  0  0  1        3          536.580  -27.910    0.        1.000          113AR
D 1          8045228  0  3 22  2        3          536.580  -27.910    1.000     1.000          113AR
D 1          8045332  0  0  0  1        3          539.000  -12.000    0.        1.000          113AR
D 1          8045332  0  1 47  3        3          539.000  -12.000    0.        1.000          113AR
D 1          8045332  0  2  0  2        3          539.000  -12.000    0.647     1.000          113AR
D 1          8045332  0  2 15  2        3          539.000  -12.000    0.772     1.000          113AR
D 1          8045332  0  2 30  2        3          539.000  -12.000    0.897     1.000          113AR
D 1          8045332  0  2 42  2        3          539.000  -12.000    1.000     1.000          113AR
D 2          8074160  0  0  0  1        1          544.000  -33.000    0.        1.000          RENG2
D 2          8074160  1  2  5  3        1          544.000  -33.000    0.        1.000          RENG2
D 2          8074160  1  8  0  2        1          544.000  -33.000    1.000     1.000          RENG2
J 1    1     9261072  0  0  0  1 12  2   24  2  541.100  -21.540    0.      0 0 0 2 0 0 111IN          0  0
J 1    1     9261072  0  0  0  2        24           70.000    1          1
J 1    1     9261072  0  0 23  3           1  2     1
J 1    1     9261072  0  1 53  5           1
J 1    1     9261072  0  1 53  6           1
J 1    1     9261072  0  1 53  7                      0.
J 1    1     9261072  0  1 53  8
J 1   10     9739420  0  0  0  1  7  3   12  1  549.000  -30.100    0.      0 0 0 1 6 0 132AR          1  0
J 1   10     9739420  0  0  0  2        12          1242.000    1          1
J 1   10     9739420  0  1 40  3           1  2     1
J 1   10     9739420  0  3 40  5           1
J 1   10     9739420  0  3 40  6           1
J 1   10     9739420  0  3 40  7                      0.
J 1   10     9739420  0  3 40  8
J 1   13     9740584  0  0  0  1  8  3   13  3  575.500  -10.750  500.000 0 0 0 0 2 0 -              15 15 COMPLEX3
J 1   13     9740584  0  0  0  2        13          1756.583    1          2
J 1   13     9740584  0  0 49  3           1  0     1
J 1   13     9740584  0  1  4  3           2  2     1
J 1   13     9740584  0  1  4  5           1
J 1   13     9740584  0  1 19  5           2
J 1   13     9740584  0  1 19  6           2
J 1   13     9740584  0  1 19  7                      0.
J 1   13     9740816  0  0  0  1  8  3   13  3  575.500  -10.750  500.000 0 0 0 0 2 0 -              15 15 COMPLEX3
J 1   13     9740816  0  1 19  3           1  0     1
J 1   13     9740816  0  1 34  3           2  2     1
J 1   13     9740816  0  1 34  5           1
J 1   13     9740816  0  1 49  5           2
J 1   13     9740816  0  1 49  6           2
J 1   13     9740816  0  1 49  7                      0.
J 1   13     9740816  0  1 49  8
J 1   14     9741608  0  0  0  1  9  3   16  3  575.500  -10.750    0.800   0 0 0 0 2 0 -              15 15 COMPLEX3
J 1   14     9741608  0  1 27  3           1  2     1
J 1   14     9741608  0  1 51  5           1
J 1   14     9741608  0  1 51  6           1
J 1   14     9741608  0  1 51  7                      0.
J 1   14     9741608  0  1 51  8
J 1   21     9742632  0  0  0  1 11  1   18  3  578.650  -13.400    0.      0 0 0 2 0 0 CORPSFWD       0  0
J 1   21     9742632  0  0  5  2        18          1762.333    1          1
J 1   21     9742632  0  0 18  3           1  0     1
J 1   21     9742632  0  0 33  5           1
J 1   21     9742632  0  0 33  6           1
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J 1   21      9742632  0  0 33  7                          0.
J 1   21      9742632  0  0 33  8
J 1   22      9742632  0  0 21  1  3  1   3   3  573.245  -16.074     0.     0  0 21  0  5 57 121IN              0   0
J 1   22      9742632  0  0 26  2           3     164.733    1         1
J 1   22      9742632  0  0 33  3           1   2   1
J 1   22      9742632  0  0 48  5           1
J 1   22      9742632  0  0 48  6           1
J 1   22      9742632  0  0 48  7                          0.
J 1   22      9742632  0  0 48  8
J 1   33      8044188  0  4  0  1 10  2   17   2  545.500  -21.900     0.     0  6  0  2  0  0 -                 16  16 COMPLEX2
J 1   33      8044188  0  6  0  2           17    1738.500    1         1
J 1   33      8044188  0  6 27  3           1   0   1
J 1   33      8044188  0  6 57  5           1
J 1   33      8044188  0  6 57  6           1
J 1   33      8044188  0  6 57  7                          0.
J 1   33      8044188  0  6 57  8
J 2   44      9261072  0 23  0  1  1  3   27   4  575.500  -10.750     0.250  0 23  0  1  6  0 11MR               0  15 COMPLEX3
J 2   44      9261072  0 23  5  2           27    2263.292    1         1
J 2   44      9261072  0 23 28  3           1   2   1
J 2   44      9261072  0 23 35  5           1
J 2   44      9261072  0 23 35  6           1
J 2   44      9261072  0 23 35  7                          0.
J 2   44      9261352  0 23  0  1  1  3   27   4  575.500  -10.750     0.250  0 23  0  1  6  0    11MR            0  15 COMPLEX3
J 2   44      9261352  0 23 35  3           1   2   1
J 2   44      9261352  0 23 43  5           1
J 2   44      9261352  0 23 43  6           1
J 2   44      9261352  0 23 43  7                          0.
J 2   44      9261352  0 23 43  8
J 2   45      9813008  0 23  0  1  3  3   35   4  575.500  -10.750     0.     0 23  0  1  6  0    11MR            0  15 COMPLEX3
J 2   45      9813008  0 23  5  2           35    2256.790    1         1
J 2   45      9813008  0 23 28  3           1   0   1
J 2   45      9813008  0 23 43  5           1
J 2   45      9813008  0 23 43  6           1
J 2   45      9813008  0 23 43  7                          0.
J 2   45      9813008  0 23 43  8
J 2   46      9261352  1  0 16  1  3  1   31   5  578.576  -13.400     0.     0  3 38  2  0  0    RENG1           0   0
J 2   46      9261352  1  0 17  2           31    166.273     1         1
J 2   46      9261352  1  0 22  3           1   2   1
J 2   46      9261352  1  0 37  5           1
J 2   46      9261352  1  0 37  6           1

J 2   46      9261352  1  0 37  7                          0.
J 2   46      9261352  1  0 37  8
J 2   47      9743376  1  0 37  1  5  4   39   5  578.576  -13.400     0.     0  3 38  2  0  0    RENG1           0   0
J 2   47      9743376  1  0 42  2           39    1261.224    1         1
J 2   47      9743376  1  2 22  3           1   0   1
J 2   47      9743376  1  8 52  5           1
J 2   47      9743376  1  8 52  6           1
J 2   47      9743376  1  8 52  7                          0.
J 2   47      9743376  1  8 52  8
L 1   BENG2              0  0 30 BATM1                    10.0       9.5
L 1   BENG2              0  0 57 WIRE                     50.0      25.0
L 1   ENGR_WT170         0 16  7 FUEL                    100.0      30.0
M 1           9646872  2  0  0     5     0       573.245  -16.074   0  0 48  2  0  0         1 BENG2                0
M 1           9646872 RIVER1              570.900       -17.700        577.100       -13.400        573.245     -16.074
M 1           9742530  0  2  0     9    15       575.500  -10.750   0  0  0  0  2  0         1 -                    15 COMPLEX3
```

SORTED ENGINEER HISTORY FILE (Cont'd)

```
M 1            9742530 TANKDITCH                    0.020                                                  0.000          3
M 2            9646960  0 12  0    12    0          543.000  -12.500   0  0  0  0 12  0        1 RENG1                 0
M 2            9646960 SV/TNK                     543.000    -12.500              0.0                      12MR
M 2            9722780  0 12 33     4    0          545.500  -21.900   0 12 33  0 19 33        2 21MR                  0
M 2            9646780 BATM3                        0.060      0.060          200.000        1.000          1
M 2            9646780 BDIRM                        0.040      0.040           10.000        1.000          1
N 1  113AR              0  2 42    12  1  23  539.000  -12.000     0.510    1.000
N 2  12MR               0 13 58     1  1  27  575.500  -10.750     0.100    1.000
N 2  12MR               0 13 59     1  1  27  575.500  -10.750     0.125    1.000
N 2  12MR               0 14  2     3  5  35  575.500  -10.750     0.250    1.000
N 2  12MR               1 13 23     1  1  27  574.575  -24.000     0.100    1.000
N 2  12MR               1 13 26     1  1  27  574.575  -24.000     0.150    1.000
N 2  12MR               1 13 27     3  1  37  570.325  -22.000     0.500    1.000
N 2  12MR               1 13 27     3  5  35  574.575  -24.000     0.350    1.000
N 2  RENG2              1  8  0    12  1  50  544.000  -33.000     4.000    1.000
T 1            9119708  0  0  0    1  0        549.000  -28.000 *
T 1            9119708  0  3 40    2  2        549.000  -30.100 BENGHQ
T 1            9119708  1  2 21    3  2        547.000  -27.209 111IN
T 1            9119708  1  6  0    3  2        549.485  -26.001 132AR
T 1            9119708  1  6 25    4  4        550.475  -30.003 132AR
```

APPENDIX B:

Formats for the Standard Engineer Reports

SUMMARY JOB REPORT BY UNIT
SIDE

HQ UNIT	TASK	NUMBER ASSIGNED	NUMBER STARTED	NUMBER COMPLETED	AVERAGE JOB TIME	NUMBER DISCONTINUED	NUMBER IN PROGRESS

SUMMARY JOB REPORT BY TASK TYPE
SIDE

TASK NAME	NUMBER GENERATED	NUMBER ASSIGNED	NUMBER STARTED	NUMBER COMPLETED	AVERAGE JOB TIME	NUMBER DISCONTINUED	NUMBER IN PROGRESS	OBS COMP COMPLETED

MINE EMPLACEMENT TOTALS

TYPE	COUNT

DETAIL JOB REPORT BY HQ UNIT
SIDE

SIDE - HQ UNIT

ORIG NBR	TASK	OBS COMP	REQUESTING UNIT	START TIME	LATE FIN TIME	COMPLETE TIME	CANCEL TIME	CANCEL REASON	PRIORITY	TECH NBR	NBR SEG	LAST SEG

DETAIL JOB REPORT BY TASK TYPE
SIDE

SIDE - TASK TYPE

ORIG NBR	REQUESTING UNIT	HQ UNIT	START TIME	LATE FIN TIME	OBS COMP	TECH NBR	LOCATION	SIZE	ASSIGN TIME	ARRIVAL TIME	COMPLETE TIME	CANCEL TIME

TASK PERFORMANCE WITH ORGANIC RESOURCES
SIDE

TIME	TASK	TECHNIQUE	UNIT	LOCATION	DURATION	EFFECT

DETAIL BREACH POINT REPORT

BREACH POINT	LOCATION	TIME	UNIT	COMP FACTOR	BLUE FLAG	RED FLAG

DETAIL COMBAT TRAILS REPORT
SIDE

COMBAT TRAIL	LOCATION	VEG TYPE	GRID TRAFF	ENG EFFECT	TIME BUILT	UNIT	SIDE	TIME INVOLVED	TRAFF LEVEL

DETAIL DEFENSIVE POSITION REPORT BY SIDE
SIDE

DEF POS ID	PROTO	LOCATION	REQUESTOR	LAST UPDATE	COMP FACTOR	TIME DESTROYED	OCCUPYING UNIT	PROTO	ARRIVAL TIME	TIME OCCUPIED	COMP FACTOR	EXPOS FACTOR

SUMMARY OF ASSETS BY UNIT
SIDE

SIDE - UNIT NAME

ASSET NAME	NBR ASSETS	AVG NBR JOBS	AVG AVAIL TIME	AVG PREP TIME	AVG TRAVEL TIME	AVG WAIT TIME	AVG WORK TIME	AVG REST TIME	AVE DAMAGED TIME	AVE AT SITE TIME	AVG UNDAMAGED PORTION	NBR DAMAGED	AVG DISTANCE TRAVEL'D

SUMMARY REPORT FOR ASSETS BY TYPE
SIDE

ASSET NAME	NBR ASSETS	AVG NBR JOBS	AVG AVAIL TIME	AVG PREP TIME	AVG TRAVEL TIME	AVG WAIT TIME	AVG WORK TIME	AVG REST TIME	AVE DAMAGED TIME	AVE AT SITE TIME	AVG UNDAMAGED PORTION	NBR DAMAGED	AVG DISTANCE TRAVEL'D

DETAIL REPORT OF ASSETS BY UNIT
SIDE

SIDE - HQ NAME

TYPE	ASSET ID	NBR JOBS	AVAIL TIME	PREP TIME	TRAVEL TIME	WAIT TIME	WORK TIME	REST TIME	DAMAGED TIME	AT SITE TIME	UNDAMAGED PORTION	DISTANCE TRAVEL'D

DETAIL REPORT OF ASSETS BY TYPE
SIDE

OWNING HQ UNIT	ASSET ID	NBR JOBS	AVAIL TIME	PREP TIME	TRAVEL TIME	WAIT TIME	WORK TIME	REST TIME	DAMAGED TIME	AT SITE TIME	UNDAMAGED PORTION	DISTANCE TRAVEL'D

SIDE - ASSET NAME

SUPPLY DEFICITS
SIDE

TRANSFER TIME	UNIT	SUPPLY TYPE	AMOUNT NEEDED	AMOUNT ON HAND

DETAIL UNASSIGNED MISSION REPORT BY SIDE
SIDE

SIDE - BREACH MINEFIELD
- CLEAR MINEFIELD
- EMPLACE MINEFIELD

ORIG NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	FEATURE	FRONTAGE	DEPTH	ORIENT	NBR MINES	LOCATION

SIDE - BREACH OBSTACLE
IMPROVE OB BREACH

ORIG NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	FEATURE	SEGMENT START LOCATION	SEGMENT END LOCATION	BRIDGE/BREACH LOCATION

SIDE - EMPLACE OBSTACLE

ORIG NBR	TME	REQUESTING UNIT	START TIME	LATE FIN TIME	FEATURE	OBSTACLE NUMBER	START LOCATION	END LOCATION

SIDE - PREPARE POSITION

ORIG NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	POSITION TYPE	LOCATION

SIDE - BREACH COMPLEX
EMPLACE COMPLEX

COMP NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	LOCATION	FEATURE	FRONTAGE	DEPTH	NBR MINES	% COMPLETE	MS NUM

SIDE - BUILD CMBT

ORIG NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	VEGETATION TYPE	LOCATION	GRID CELL LOCATION

SIDE - REPAIR RD CRATER
CRATER ROAD
MAINTAIN ROAD

ORIG NBR	TIME	REQUESTING UNIT	START TIME	LATE FIN TIME	ROAD TYPE	LOCATION

APPENDIX C: Formats for the Database Files

SYSTEM TABLE - SY.ING

```
EN.DATA.BASE.PREFIX                                  T 5, /,
EN.SCENARIO.NAME                                     T 130, /,
EN.SCENARIO.TITLE                                    T 130, /,
EN.HISTORY.FILE                                      I 2, *, *,
EN.REPORT.FILE                                       I 2, *, *,
EN.SETUP.FILE                                        I 2, *, *,
EN.OUTPUT.FILE.NAME                                  T 20, *, *,
EN.RUN.TIME                                          D(6,3), /,
TB.X.ORIGIN                                          D(8,3), *, *,
TB.Y.ORIGIN                                          D(8,3), *, *,
TB.GRID.WIDTH.X                                      D(8,3), *, *,
TB.GRID.WIDTH.Y                                      D(8,3), *, *,
TB.N.GRID.X                                          I 3, *, *,
TB.N.GRID.Y                                          I 3, /,
EN.LAST.OF.BLUE.HQ                                   I 4, *, *,
EN.LAST.OF.RED.HQ                                    I 4, *, *,
N.EN.ASSIGNED.MISSION                                I 4
```

SIDE TABLE - SI.ING

```
EN.DATA.BASE.PREFIX                                  T 5, *,*,
.SIDE                                                I 3, *,*,
SS.SIDE.NAME (.SIDE)                                 T 17, *,*,
N.EN.SET.OF.NON.ENGINEER (.SIDE)                     I 4, *,*,
N.EN.SET.OF.LO.RECORDS (.SIDE)                       I 4, *,*,
N.EN.SET.OF.DEFENSIVE.POSITIONS (.SIDE)              I 4, *,*,
N.EN.SET.OF.COMBAT.TRAILS (.SIDE)                    I 4, /
```

TASK TABLE - TS.ING

```
EN.DATA.BASE.PREFIX                                  T 5, *,*,
.TASK                                                I 3, *,*,
EN.TASK.NAME (.TASK)                                 T 17, *,*,
N.EN.SET.OF.ASSIGNED.MISSIONS (.TASK)                I 4, *,*,
N.EN.SET.OF.UNASSIGNED.MISSIONS (.TASK)              I 4, /
```

HQ TABLE - HQ.ING

```
EN.DATA.BASE.PREFIX                                  T 5, *,*,
.HQ                                                  I 2, *,*
EN.HQ.NAME (.HQ)                                     T 18, *,*,
EN.HQ.SIDE (.HQ)                                     I 1, *,*,
N.EN.HQ.INVENTORY (.HQ)                              I 4, *,*,
N.EN.HQ.MISSION.LIST (.HQ)                           I 4, /
```

ASSET PROTO TABLE - AP.ING

```
EN.DATA.BASE.PREFIX                                  T 5, *,*,
.AP                                                  I 3, *,*,
EN.ASSET.NAME (.AP)                                  T 18, *,*,
N.EN.SET.OF.ASSETS (.AP)                             I 4, /
```

ASSET TABLE - AS.ING

```
EN.DATA.BASE.PREFIX                                  T 5, *,*,
EN.ASSET.ID (.ASSET)                                 I 8, *,*,
EN.ASSET.SIDE (.ASSET)                               I 1, *,*,
EN.ASSET.TYPE (.ASSET)                               I 3, *,*,
EN.ASSET.NAME (.PROTO)                               T 15, *,*,
EN.HQ.NAME (EN.ASSET.UNIT.ASSIGNMENT (.ASSET))       T 16, *,*,
```

```
EN.ASSET.UNDAMAGED.PORTION (.ASSET)                    D(5,3), *,*,
EN.ASSET.DISTANCE (.ASSET)                             D(7,2), *,*,
N.EN.SET.OF.ASSET.JOBS (.ASSET)                        I 3, /
```

ASSET TIME TABLE - AT.ING

```
EN.DATA.BASE.PREFIX                                    T 5, *,*,
EN.ASSET.ID (.ASSET)                                   I 8, *,*,
EN.ASSET.TYPE (.ASSET)                                 I 3, *,*,
FOR I = 1 TO ..NUMBER.STATES
      .ASSET.ARRAY (I) * 24                            D(6,2)
      ..COMMA                                          T 1,
      ..BLANK                                          T 1,
There are currently eight states:  available, pre task, in transit,
      waiting, working, in rest period, damaged and left at site.
```

ASSET JOB TABLE - AJ.ING

```
EN.DATA.BASE.PREFIX                                    T 5, *,*,
EN.ASSET.ID (.ASSET)                                   I 12, *,*,
EN.ASSET.MISSION.PTR (.ASSET.JOB)                      I 4, *,*,
EN.ASSET.JOB.PTR (.ASSET.JOB)                          I 12 , *,*,
EN.ASSET.JOB.X.LOC (.ASSET.JOB)                        D(8,3), *,*,
EN.ASSET.JOB.Y.LOC (.ASSET.JOB)                        D(8,3), /
```

MISSION TABLE - MS.ING

```
EN.DATA.BASE.PREFIX                                    T 5, *,*,
.MISSION                                               I 4, *,*,
EN.MISSION.SIDE (.MISSION)                             I 1, *,*,
EN.MISSION.TASK (.MISSION)                             I 3, *,*,
EN.MISSION.FEATURE (.MISSION)                          I 3, *,*,
EN.MISSION.HQ.UNIT(.MISSION)                           I 4, *,*,
EN.MISSION.ORIGINAL.MISSION (.MISSION)                 I 4, *,*,
EN.MISSION.REQUESTOR (.MISSION)                        T 15, *,*,
EN.MISSION.EARLIEST.START.TIME (.MISSION)              D(8,3), *,*,
EN.MISSION.REQUIRED.COMPLETION.TIME (.MISSION)         D(8,3), *,*,
EN.MISSION.COMPLETION.TIME (.MISSION)                  D(8,3), *,*,
N.EN.SET.OF.JOBS (.MISSION)                            I 5, *,*,
EN.MISSION.OC.ID (.MISSION)                            I 4, *,*,
EN.MISSION.OC.NAME (.MISSION)                          T 15, /
```

JOB TABLE - JB.ING

```
EN.DATA.BASE.PREFIX                                    T 5, *,*,
EN.JOB.NUMBER(.JOB)                                    I 12, *,*,
.MISSION                                               I 4, *,*,
EN.JOB.TECHNIQUE(.JOB)                                 I 4, *,*,
EN.JOB.X.LOCATION(.JOB)                                D(8,3), *,*,
EN.JOB.Y.LOCATION(.JOB)                                D(8,3), *,*,
EN.JOB.SIZE(.JOB)                                      D(9,3), *,*,
EN.JOB.PRIORITY(.JOB)                                  D(9,3), *,*,
EN.JOB.NBR.SEG (.JOB)                                  I 4, *,*,
EN.JOB.COMPLETED.EFFECT (.JOB)                         D(8,3), *,*,
EN.JOB.DISCONTINUE.REASON (.JOB)                       I 4, *,*,
N.EN.SET.OF.SEGMENTS (.JOB)                            I 4, /
```

JOB_TIME TABLE - JT.ING

```
EN.DATA.BASE.PREFIX                                    T 5, *,*,
EN.JOB.NUMBER(.JOB)                                    I 12, *,*,
EN.JOB.ASSIGNMENT.TIME (.JOB)                          D(8,3), *,*,
EN.JOB.ACTIVATION.TIME (.JOB)                          D(8,3), *,*,
EN.JOB.COMPLETION.TIME (.JOB)                          D(8,3), *,*,
EN.JOB.DISCONTINUE.TIME (.JOB)                         D(8,3), *,*,
.MISSION                                               I 3, /
```

JOB_SEGMENT TABLE - JS.ING

```
EN.DATA.BASE.PREFIX                          T 5, ",",
EN.JOB.NUMBER (.JOB)                         I 12, ",",
EN.SEGMENT.NBR (.SEG)                        I 3, ",",
EN.SEGMENT.BEGIN.TIME (.SEG)                 D(8,3), ",",
EN.SEGMENT.END.TIME (.SEG)                   D(8,3), ",",
EN.SEGMENT.DELAY.TIME (.SEG)                 D(8,3), ",",
EN.SEGMENT.NBR.WT (.SEG)                     I 2, ",",
EN.SEGMENT.DELAY.INDICATOR (.SEG)            I 3, ",",
.MISSION                                     I 4, /
```

NON ENGINEER TABLE - NE.ING

```
EN.DATA.BASE.PREFIX                          T 5, ",",
EN.NEJ.UNIT (.NEJ)                           T 15, ",",
.SIDE                                        I 1, ",",
EN.NEJ.TASK (.NEJ)                           I 3, ",",
EN.NEJ.FEATURE (.NEJ)                        I 3, ",",
EN.NEJ.TECHNIQUE (.NEJ)                      I 4, ",",
EN.NEJ.X.LOC (.NEJ)                          D(8,3), ",",
EN.NEJ.Y.LOC (.NEJ)                          D(8,3), ",",
EN.NEJ.END.TIME (.NEJ)                       D(8,3), ",",
EN.NEJ.DURATION (.NEJ)                       D(8,3), ",",
EN.NEJ.COMPLETION (.NEJ)                     D(8,3), /
```

BREACH POINT TABLE - BP.ING

```
EN.DATA.BASE.PREFIX                          T 5, ",",
EN.BP.ID (.BP)                               I 12, ",",
EN.BP.X.LOC (.BP)                            D(8,3), ",",
EN.BP.Y.LOC (.BP)                            D(8,3), ",",
EN.BP.SIDE (.BP.ACT)                         I 2, ",",
EN.BP.TIME (.BP.ACT)                         D(8,3), ",",
EN.BP.UNIT.NAME (.BP.ACT)                    T 15, ",",
EN.BP.COMPLETION.FACTOR (.BP.ACT)            D(8,3), ",",
EN.BP.BLUE.DEMO.FLAG (.BP.ACT)               I 2, ",",
EN.BP.RED.DEMO.FLAG (.BP.ACT)                I 2, /
```

DEFENSIVE POSITION TABLE - DP.ING

```
EN.DATA.BASE.PREFIX                          T 5, ",",
EN.DP.ID (.DP)                               I 12, ",",
.SIDE                                        I 1, ",",
EN.DP.PROTO (.DP)                            I 4, ",",
EN.DP.X.LOC (.DP)                            D(8,3), ",",
EN.DP.Y.LOC (.DP)                            D(8,3), ",",
EN.DP.CREATION.TIME (.DP)                    D(8,3), ",",
EN.DP.LAST.UPDATE.TIME (.DP)                 D(8,3), ",",
EN.DP.DESTROYED.TIME (.DP)                   D(8,3), ",",
EN.DP.UNIT.NAME (.DP)                        T 15, ",",
EN.DP.TIME.USED (.DP)                        D(8,3), ",",
EN.DP.COMPLETION.FACTOR (.DP)                D(8,3), ",",
EN.DP.EXPOSURE.FACTOR (.DP)                  D(8,3), ",",
EN.DP.NUMBER.SAVED (.DP)                     D(8,3), ",",
N.EN.SET.OF.DP.OCCUPYING.UNITS (.DP)         I 4, /
```

DEFENSIVE POSITION OCCUPYING UNIT TABLE - DU.ING

```
EN.DATA.BASE.PREFIX                          T 5, ",",
EN.DP.ID (.DP), .SIDE                        I 12, ",",
EN.OU.NAME (.DP.UNIT)                        I 1, ",",
EN.OU.PROTO (.DP.UNIT)                       T 15, ",",
EN.OU.ARRIVAL.TIME (.DP.UNIT)                I 4, ",",
EN.OU.COMPLETION.FACTOR (.DP.UNIT)           D(8,3), ",",
EN.OU.TIME.OCCUPIED (.DP.UNIT)               D(8,3), ",",
```

```
EN.OU.EXPOSURE.FACTOR (.DP.UNIT)                    D(8,3), /
```

COMBAT TRAIL TABLE - TR.ING

```
EN.DATA.BASE.PREFIX                                 T 5, ",",
EN.CT.ID (.CT)                                      I 12, ",",
.SIDE                                               I 1, ",",
EN.CT.TYPE (.CT)                                    T 5, ",",
EN.CT.X.LOC (.CT)                                   D(8,3), ",",
EN.CT.Y.LOC (.CT)                                   D(8,3), ",",
EN.CT.X.JOB.LOC (.CT)                               D(8,3), ",",
EN.CT.Y.JOB.LOC (.CT)                               D(8,3), ",",
EN.CT.BUILD.TIME (.CT)                              D(6,3), ",",
EN.CT.EFFECT (.CT)                                  D(8,3), ",",
EN.CT.GRID.TRAFF (.CT)                              I 2, ",",
N.EN.SET.OF.CT.USING.UNITS (.CT)                    I 4, /
```

TRAIL USING UNIT TABLE - TU.ING

```
EN.DATA.BASE.PREFIX                                 T 5, ",",
EN.CT.ID (.CT)                                      I 12, ",",
.SIDE                                               I 1, ",",
EN.CU.NAME (.CT.UNIT)                               T 15, ",",
EN.CU.ENTER.TIME (.CT.UNIT)                         D(6,3), ",",
EN.CU.EXIT.TIME (.CT.UNIT)                          D(6,3), ",",
EN.CU.X.ENTER (.CT.UNIT)                            D(8,3), ",",
EN.CU.Y.ENTER (.CT.UNIT)                            D(8,3), ",",
EN.CU.X.EXIT (.CT.UNIT)                             D(8,3), ",",
EN.CU.Y.EXIT (.CT.UNIT)                             D(8,3), ",",
EN.CU.TRAFF.LEVEL (.CT.UNIT)                        I 2, /
```

LOGISTICS TRANSFER TABLE - LT.ING

```
EN.DATA.BASE.PREFIX                                 T 5, ",",
EN.TRANSFER.TIME (.LO.REC)                          D(6,3), ",",
EN.GIVING.UNIT (.LO.REC)                            T 12, ",",
EN.RECEIVING.UNIT (.LO.REC)                         T 16, ",",
EN.SUPPLY.TYPE (.LO.REC)                            T 16, ",",
EN.AMT.REQUESTED (.LO.REC)                          D(8,3), ",",
EN.AMT.ON.HAND (.LO.REC)                            D(8,3) , /
```

UNASSIGNED MISSION TABLE - UM.ING

```
EN.DATA.BASE.PREFIX                                 T 5, ",",
EN.UM.NUMBER (.MISSION)                             I 12, ",",
EN.UM.SIDE (.MISSION)                               I 1, ",",
EN.UM.TASK (.MISSION)                               I 4, ",",
EN.UM.ORIG.NBR (.MISSION)                           I 4, ",",
EN.UM.METHOD (.MISSION)                             I 3, ",",
EN.UM.REQUESTOR (.MISSION)                          T 15, ",",
EN.UM.START.TIME (.MISSION)                         D(8,3), ",",
EN.UM.REQUIRED.COMPLETION.TIME (.MISSION)           D(8,3), ",",
EN.UM.CURRENT.TIME (.MISSION)                       D(8,3), ",",
EN.UM.X.LOC (.MISSION)                              D(8,3), ",",
EN.UM.Y.LOC (.MISSION)                              D(8,3), ",",
N.EN.SET.OF.FEATURES (.MISSION)                     I 4, ",",
EN.UM.OC.ID (.MISSION)                              I 4, ",",
EN.UM.OC.NAME (.MISSION)                            T 15, /
```

MINEFIELD FEATURE TABLE - MF.ING

```
EN.DATA.BASE.PREFIX                                 T 5, ",",
EN.UM.NUMBER (.MISSION)                             I 12, ",",
EN.MINEFIELD.TYPE (.FEATURE)                        T 14, ",",
EN.MINEFIELD.FRONTAGE (.FEATURE)                    D(9,3), ",",
EN.MINEFIELD.DEPTH (.FEATURE)                       D(9,3), ",",
```

```
EN.MINEFIELD.ORIENT (.FEATURE)                  D(9,3), ",",
EN.MINEFIELD.X.LOC (.FEATURE)                   D(9,3), ",",
EN.MINEFIELD.Y.LOC (.FEATURE)                   D(8,3), ",",
EN.MINEFIELD.NBR.MINES(.FEATURE)                D(8,3), ",",
.TASK                                           I 4, /
```

BREACH FEATURE TABLE - BF.ING

```
EN.DATA.BASE.PREFIX                             T 5, ",",
EN.UM.NUMBER (.MISSION)                         I 12, ",",
EN.BREACH.TYPE (.FEATURE)                       T 12, ",",
EN.BREACH.X.START (.FEATURE)                    D(8,3), ",",
EN.BREACH.Y.START (.FEATURE)                    D(8,3), ",",
EN.BREACH.X.END (.FEATURE)                      D(8,3), ",",
EN.BREACH.Y.END (.FEATURE)                      D(8,3), ",",
EN.BREACH.X.LOC (.FEATURE)                      D(8,3), ",",
EN.BREACH.Y.LOC (.FEATURE)                      D(8,3), ",",
.TASK                                           I 4, /
```

OBSTACLE FEATURE TABLE - OF.ING

```
EN.DATA.BASE.PREFIX                             T 5, ",",
EN.UM.NUMBER (.MISSION)                         I 12, ",",
EN.OBSTACLE.TYPE (.FEATURE)                     T 15, ",",
EN.OBSTACLE.NBR (.FEATURE)                      I 8, ",",
EN.OBSTACLE.X.START (.FEATURE)                  D(8,3), ",",
EN.OBSTACLE.Y.START (.FEATURE)                  D(8,3), ",",
EN.OBSTACLE.X.END (.FEATURE)                    D(8,3), ",",
EN.OBSTACLE.Y.END (.FEATURE)                    D(8,3), ",",
.TASK                                           I 2, /
```

POSITION FEATURE TABLE - PF.ING

```
EN.DATA.BASE.PREFIX                             T 5, ",",
EN.UM.NUMBER (.MISSION)                         I 12, ",",
EN.POSITION.TYPE (.FEATURE)                     T 15, ",",
EN.POSITION.X.LOC (.FEATURE)                    D(8,3), ",",
EN.POSITION.Y.LOC (.FEATURE)                    D(8,3), ",",
EN.POSITION.COMPLETION.FACTOR (.FEATURE)        D(8,3), ",",
EN.POSITION.REQUESTING.UNIT (.FEATURE)          T 15, ",",
.TASK                                           I 2, /
```

TRAIL FEATURE TABLE - TF.ING

```
EN.DATA.BASE.PREFIX                             T 5, ",",
EN.UM.NUMBER (.MISSION)                         I 12, ",",
EN.TRAIL.TYPE (.FEATURE)                        T 20, ",",
EN.TRAIL.X.GRID (.FEATURE)                      I 5, ",",
EN.TRAIL.Y.GRID (.FEATURE)                      I 5, ",",
EN.TRAII .EFFECT (.FEATURE)                     D(9,3), ",",
.TASK                                           I 2, /
```

ROAD FEATURE TABLE - RF.ING

```
EN.DATA.BASE.PREFIX                             T 5, ",",
EN.UM.NUMBER (.MISSION)                         I 12, ",",
EN.ROAD.TYPE (.FEATURE)                         I 2, ",",
.TASK                                           I 2, /
```

OBSTACLE COMPLEX FEATURE TABLE - CF.ING

```
EN.DATA.BASE.PREFIX                             T 5, ",",
EN.UM.NUMBER (.MISSION)                         I 12, ",",
EN.COMPLEX.TYPE (.FEATURE)                      T 14, ",",
EN.COMPLEX.FRONTAGE (.FEATURE)                  D(9,3), ",",
EN.COMPLEX.DEPTH (.FEATURE)                     D(9,3), ",",
```

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8/93

☆ U.S. GOVERNMENT PRINTING OFFICE: 1993—3510-S/80058